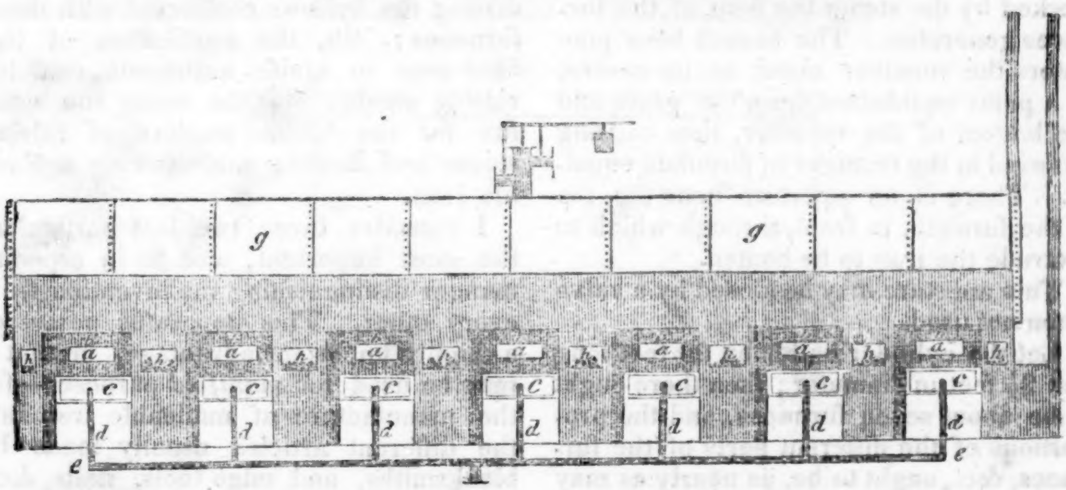
③ MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME VI.] JULY, 1835. [NUMBER 1.

IMPROVED PROCESS OF GENERATING HEAT AND STEAM.



We have been favored by Mr. Clute, of Schenectady, with the annexed specification and engraving of his improved furnace.

References—*a a*, apertures for iron; *b b*, grates; *c c*, receivers; *d d*, branches of main blow-pipe; *e e*, main blow-pipe; *g g*, cylinder boiler; *h h*, apertures for coal.

Specification of a Patent granted to PETER I. CLUTE, *of Schenectady, New-York, for an Improvement in the Process of generating Heat, for forging Malleable Iron, and generating Steam to propel Machinery.*

Be it known, that I, Peter I. Clute, of the city of Schenectady, in the county of Schenectady, and state of New-York, have invented a new and useful improvement in the art or process of generating heat for forging malleable iron, and of generating steam to propel machinery for the purpose of grinding and polishing iron when manufactured, and for the other purposes for which steam power is generally employed.

The following is a description of the construction and operation of the furnaces and apparatus to be used in my invention.

Where other than a cylinder boiler, or where more than one boiler, is designed to be used, a given number of furnaces of the description hereinafter set forth, are to be erected under the same, arranged in the most convenient form, to receive as many points of the boiler or boilers, as, according to the principles hereinafter laid down, may be deemed most expedient; as, for example, in a circular form.

The *cylinder* boiler, however, I deem best adapted to the contemplated purposes of my invention.

Where the cylinder boiler is used, the number and size of the furnaces will vary according to the size of the boiler, and the quantity of steam required to be raised. The furnaces are to be built in a straight line, of uniform width and height, equidistant and continuous, the boiler to be laid horizontally or lengthways on the top of the furnaces. There is an aperture at either end of each furnace, through which the coal is shoved on the grate, and the fires fed as occasion requires. Under each grate there is a box, which I shall designate by the

name of receiver, because it receives the blasts from the blow-pipe and the ashes falling through the grate. The receiver may be taken out and cleaned when necessary. Each receiver has at one of its sides an aperture for receiving a branch of the blow-pipe. There are, of course, as many branches to the main blow-pipe as there are furnaces, and the blow-pipe is connected with the bellows, which is worked by the steam the heat of the furnaces generates. The branch blow-pipe enters the receiver about at its centre, at a point equidistant from the grate and the bottom of the receiver, thus causing the wind in the receiver to circulate equally. There is an aperture near the top of the furnace, in front, through which to protrude the iron to be heated.

This aperture may be closed by a valve when not used.

Let the cylinder boiler be 20 feet long and $2\frac{1}{2}$ feet in diameter; then there ought to be about seven furnaces, and the proportions of the different parts of the furnaces, &c., ought to be, as nearly as may be, as follows: Distance between the grate and the boiler, twelve inches; length of grate, eighteen inches; width of grate, eight inches; width of the furnace to correspond with the size of the grate; the aperture at either end, to admit the coal, to be 8 inches in width, and 6 inches in height; the receiver, 8 inches in width, and 6 inches in height; aperture for receiving the blow-pipe, $1\frac{1}{2}$ inch in diameter; aperture through which to heat the iron intended to be worked, 6 inches in width, and three inches in height; distance between each grate, three eighths of an inch; diameter of blow-pipe, 4 inches, and diminished to one inch and a half at the entrance into the receiver.

The strength of the blast required is equal to that of a blacksmith's fire. The degree of heat may be regulated by valves placed in the blow-pipe.

I do not claim to have discovered or invented any thing new in the construction of the furnaces *abstractly* considered, or in any of the apparatus connected with the steam engine, nor can my invention in strictness be considered as an improvement of a machine or instrument previously patented; nor can it be considered an application of an old instrument or machine to a new purpose. What I claim as *new*, and my own invention, may be reduced to the following particulars:

1st, The using a number of furnaces to raise steam; 2d, the process of heating the boiler *uniformly* at many points, thus differing from the universal practice which now obtains, of heating the boiler at one particular point; 3d, the employing the same steam raised by the furnaces in driving the bellows connected with these furnaces; 4th, the application of the blow-pipe to ignite anthracite coal for raising steam; 5th, the using the same fire for the double purpose of raising steam and heating and working malleable iron.

I consider these two last particulars the most important, and as in especial manner distinguishing my invention from every other. This apparatus possesses a highly important advantage, in that it may be used for *manifold* purposes—for the manufacture of malleable iron into the different articles usually made by blacksmiths, and edge tools, nails, &c., and the steam power may be applied to grinding and polishing the iron, when manufactured, to propelling boats, driving a trip-hammer and mills of every description, and the other purposes for which steam power is generally employed.

PETER I. CLUTE.

[For the Mechanics' Magazine.]

Specification of a Patent granted to THOS. B. STILLMAN, *for an Improvement in the Valves of Steam Engines.*

To all whom it may concern—Be it known, that I, Thomas B. Stillman, of the city of New-York, in the county and state of New-York, have invented a new and useful improvement in the valves of steam engines, the object and intent of which is to combine the common slide steam valves with a cut-off valve, so that both may be operated by the same eccentric, or cam, upon the same seat, and each retain their distinctive character for the particular purposes of a steam and cut-off valve. And the method by which I obtain such object is fully set forth in the following specification, and in the drawings thereunto annexed, which make a part of said specification.

The valve which I propose to adopt, will apply, with trifling variations, to

Fig. 2.

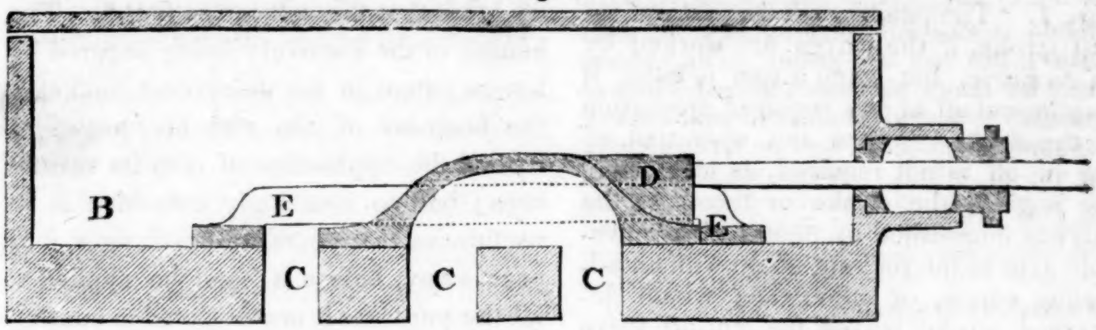


Fig. 3.

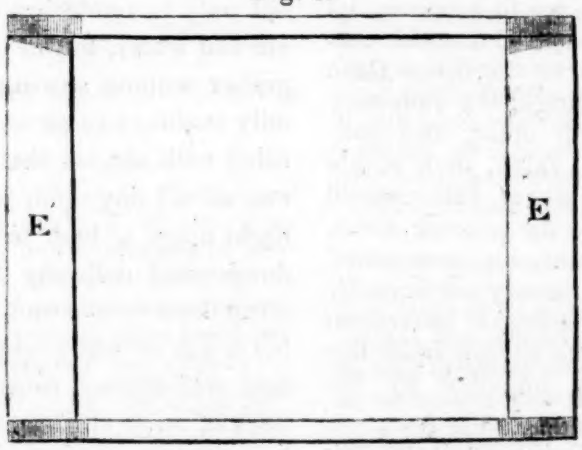
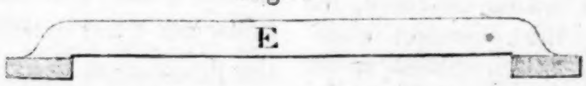


Fig. 4.



most of the different forms of sliding steam valves that are now in use. But the form to which I shall confine myself in this description is that called the single short slide valve, the adaptation of said valve to which will enable me to explain its principle in the fewest words.

Fig. 1* is a perspective of a steam chest containing the steam and cut-off valves, as hereinafter described. Fig. 2 is a longitudinal section of steam chest and valves. Fig. 3 is a plan, and fig. 4 is a side view of the cut-off valve. The letters of reference designate the similar parts in the several figures. A A is a steam chest, the lever being removed to show the valves within. B is the valve seat, which is made somewhat longer than the usual proportions, for the purpose of admitting the cut-off valve upon it, within the steam chest, and also to allow the steam valve more vibration than is commonly necessary. C C C, are the openings in the valve seat, over which the valves operate. D is the common slide valve, with the valve rod passing through the end of the steam chest. E E is the cut-off valve, which may be formed of several pieces, or cast in one piece of brass, or other metal suitable for the purpose. The two ends of this valve are faced to suit the face of the valve seat, and the inner edges are jointed to the ends of the steam valve so as to be steam tight when in contact, which will be alternately at each end of the valve when in operation. The distance between the inner edges of the ends of the cut-off valve should be equal to the length of the steam valve, and of one of the openings in the valve seat. Through the space formed by this difference of length, the steam enters the openings. But the stroke of the valve is not complete until the end of the cut-off is drawn over the opening now seen between the two valves in fi-

* Fig. 1 is omitted.

gure 1. The steam will be cut off at half stroke, if the valves are worked by an *eccentric*, but when a *cam* is used, it may be cut off at any required proportion of the stroke. When the operation of the cut-off is not required, as in starting the engine, the stroke or throw of the valve is diminished by means of a moveable arm in the rocking shaft, with an adjusting screw, or otherwise, which decreased stroke leaves the cut-off valve nearly at rest upon the valve seat, while the steam valve continues to perform its functions. It is not essential that the cut-off valve should preserve the frame form that it has in the drawings; the ends may be separate from each other, and connected to the steam valve, or a single connection over the steam valve would answer. But I prefer the present form, as it is not only better, on account of strength, but is more easily confined by the springs which I cause to bear upon each side, to prevent its sliding upon the valve seat, except as impelled by the steam valve.

What I claim as my invention and improvement in valves of steam engines, is the attaching of the frame or valve, as above described, to the common slide valves by which they are combined, so as to require but one eccentric or cam, for their proper movement and effect, both as a steam and cut-off valve, the whole being effected substantially as above described, and in any required proportion, according to the size of the engine.

In witness whereof, &c.

December 1, 1833.

The following letter from Mr. Thomas, of Keeseville, refers to a subject, which, though it has been some time before the public, appears from various causes to have received but a small portion of the attention it merits. To find the true solvent for caoutchouc, or Indian rubber, was a desideratum long sought for by ingenious and scientific men, and great anticipations of the benefits to be derived from it were indulged in, if it could be found; but great as they were, they appear to have borne scarcely the slightest proportion to what proves to be the reality, now that the solvent is found. The benefit of the discovery being secured by letters patent to the discoverer, makes it the business of him and his assigns to extend the application of it to its various uses; but so amazingly extensive is its usefulness, that years, and even ages, may pass away, before it shall be applied to all the purposes it is calculated to answer. When we see its wonderful efficiency, not only in rendering cloth impervious to air and water, but in joining the edges together without sewing—when we see not only cushions to sit on, but beds to lie on, filled with air, so that a stage passenger can sit all day upon a seat, and sleep at night upon a bed, infinitely softer than down—and deflating both in a moment, wrap them up and tuck them in a corner of his trunk or walle t—who, after seeing all this, will attempt to prescribe limits to the uses of such an invention, or who would be without a suit of clothes of it to wear in wet weather, if he could get them? I know not what calculations are made by the proprietors to extend it, but I will venture to say, when the patent expires, if not before, few sails will be seen which are not prepared with Indian rubber; and I think, also, the Mechanics' Magazine may be benefitted by the communications of Mr. Thomas. S. B.

Keeseville, Clinton co., N. Y., May 17, 1835.

S. Blydenburgh, Esq.: Sir,—In this age of "Indian rubber," will you permit me to submit to you, whether the application of that article to the sails of vessels of every description would not be highly advantageous to the interests of merchants and the government? Some of the advantages which have occurred to me as likely to be derived from its use, are the preservation of the cloth from mildew, its rendering the texture firmer, more elastic, and of course capable of enduring greater tension when in use. In wet weather the sails would be lighter, and more easily managed. I think if coal tar be the solvent used in making the varnish, the expense attending the pro-

cess of covering the cloth would not be equal to the benefits arising from its use; but in this I may be in error.

I can think of but one objection to its use: it is *possible* that spontaneous combustion might ensue when sails should be stowed away in large quantity, and in a *close, warm* situation.

If you think, sir, the suggestion has any value, please communicate it (if new) to your friend Mr. Minor, of the Mechanics' Magazine, and oblige, very respectfully, your obedient servant,

J. Thomas.

On the Use of Plated Glass as Sheathing for Ships' Bottoms.

To the Editor of the Mechanics' Magazine:

Sir,—Much ingenuity has been employed for a long time to invent a sheathing, or bottom, for ships, which would not be subject to corrosion by salt water, and at the same time avoid the accumulation of animalculæ and dirt attendant upon most bottoms which have heretofore been used.

I have thought that the following plan would be free from the usual difficulties, and have taken the liberty of introducing it to your notice. It is possible, however, that it may not be new, and that it may have been tested, but, as far as I have been able to learn, it has not. It consists of plates of different dimensions, size, thickness, and shapes, adapted to the size and form of the ship to be plated. They are to be made from glass, and the same earth and clay from which the wares denominated stone, earthen, and crockery wares, are made, (or from any others capable of being applied to such purposes,) and are to be polished in the same manner, or in any other way, on that surface intended to be exposed to the water. They are to be made with holes of sufficient size to admit screws or nails to pass through them for fastening. These holes are to be so formed, that the nails or screws shall catch and hold the plates below their outer surface. The cavities between the heads of the screws or nails, and the outer surface of the plates, and the crevices, or space between the plates, are to be filled with water lime, or any other matter, or composition of matter, which will protect the heads of the screws or nails from corrosion, and the bottom of the ship from the water, and give the plating a smooth and even surface.

If I am acquainted with the nature of the articles from which the above plates are proposed to be made, they will not be subject to corrosion, will resist all attacks by animalculæ, keep clean and smooth, and will not be worn by the friction of water. By their being made about one inch, or an inch and a half in thickness, and about a foot square, they will possess much strength. There is an objection which may be insuperable: that is, their danger of being broken by anchor cables. If that be an objection, perhaps it might be obviated by using copper, or some plan might be invented to prevent the cables from coming in contact with the bottom.

I presume that others may have thought of using glass for ships' bottoms, and I have heard it suggested that glass would do away all difficulties; but the suggesters have been at a loss to know how it should be put on to bottoms. If the putting of it on is all the difficulty, it is obviated by making it into such plates as I have described, and I am not aware that this plan has ever been proposed or tried by any person.

Many would look upon a plan for glass or stone ship bottoms as ridiculous; but when they come to consider, that these bottoms are composed of plates of a small size, and of considerable thickness, which renders them much stronger than a whole bottom of glass or stone, and far less liable to be broken, and if broken easily repaired, they might be inclined to regard it more favorably. The expense for plating a ship with these could not vary much from the present expense of coppering; but when a ship is once plated with glass, it is, as it were, plated forever, unless by some sudden blow upon the bottom it might be broken. We do not, however, expect a ship to strike the ground, or a rock, without doing great damage, whatever may be her bottom.

I have thus troubled you with an imperfect and disconnected statement of what I conceived might be an improvement in ship's bottoms; and I have endeavored to give you a few of my ideas in relation to it. They may be correct, and they may be grossly incorrect. If it should be deserving of any notice by one so capable as yourself to judge of its merit or demerit, I shall be much gratified and honored; if it is not, I shall not be disappointed. If my plan, or any part of it, shall be worthy of notice, I no doubt shall find that notice in your valuable Magazine; if it is not, I shall expect it to be treated accordingly.

I shall, in any event, have the consciousness of having made an endeavor to benefit mankind.

Yours, very respectfully,

Rosrim.

Utica, March 31, 1835.

Aerial Steam Boats.—Some sixteen or eighteen years since, I passed a day at a tavern in Hanover, N. H. with Mr. Maury,

the inventor of the rotary steam engine, used in the glass-honse at Lechmere Point, and who has made numerous experiments on light, heat and combustion, and in various branches of mechanics. He stated that he should live to see the mail transported by carriages, propelled by steam, between our largest cities, and that I should live to see it carried in steamboats through the air. On expressing doubts of the practicability of the latter improvement, in the mode of transmitting intelligence, he went into a long argument to prove, that it was not only possible, but absolutely easy of accomplishment. It has been ascertained, he observed, that large weights can be elevated high above the earth, by balloons filled with air, lighter than that of the atmosphere. The first grand step, then has been securely taken, and it is only necessary to apply a power which shall give the balloon a horizontal motion, when a rudder can be applied to guide it, and this can be done by a steam engine, working paddle-wheels as in a steamboat on our waters, but each of the paddles to move on an axis so as to offer no resistance, after having struck the air in one direction. The balloon must be constructed in the form of a fish, or in other words, have length, and such a structure as will be most easily propelled and guided, while space is afforded for the machinery and passengers. He had estimated the requisite size of a steam aerial boat to sustain an engine capable of propelling it sixty miles an hour. After many details, this intelligent, ingenious, and sanguine gentleman, closed his remarks with this bold and prophetic declaration, "You, sir, if you live to the common age of man, will see aerial steamboats rise up out of our large cities every morning, like a flock of wild geese, and take their several directions to the various parts of the Union, laden with the mails and passengers."

Notwithstanding the doubts which are generally entertained of the ultimate benefit to be derived from balloon experiments, a very scientific man, many years since, did foretell the establishment of railroads, and may not be mistaken as to the aerial ocean being successfully navigated. It would not be more wonderful than was the first steamboat which the illustrious Fulton launched upon the Hudson, or the sight of the first locomotive, which sped like the wind from Liverpool to Manchester.—[Boston Atlas.]

A Railroad from Athens to the Piræus is stated by the Munich Journal to have been contracted for by the Greek Government, with the banker Fereldi.—[Lond. Mech. Mag.]

[For the Mechanics' Magazine.]

LOCOMOTIVE STEAM ENGINES.

The friends of the resolution for taking off the duties from locomotive steam engines, which was brought forward during the last session of Congress, urged in support of that measure the incompetency of the workshops of this country to supply the demand, and the inferiority of American locomotive engines.

It may be interesting to some of your readers to learn how little this argument is supported by the facts of the case. In a visit to the workshop of Mr. M. W. Baldwin, of Philadelphia, from which I have just returned, I collected the following information: Mr. B. has delivered from his workshop, within the last twelve months, ten locomotive steam engines, has six now in his shop in a state of great forwardness, some of which are nearly completed, and has contracts on hand for about twenty engines, for the following roads, viz.: the Columbia, Pa., State Road; the Trenton, the Newark, the Jamaica, the Troy and Saratoga, and the Utica and Schenectady roads. Under his present arrangements, he informed me that he gives employment to about 150 persons, and is able to complete an engine about every three weeks; and, to meet the increasing demand, is erecting workshops which will accommodate 300 hands.

As regards the character of these engines, there are seven of them at work on the Pennsylvania State road, upon which they have also two English engines, from the workshop of their most celebrated maker, R. Stephenson.

The engineer who has charge of the locomotive department on this road, informed me that the power of the American engines is about 35 per cent. greater than that of the English, and that the loss of time, and cost for repairs, is *altogether in favor of the American engines:* five hands, as he stated, having been sufficient to keep all the seven in order.

For the gratification of such of your readers as are interested in railroads, I will refer to the principal points of difference between the English and American engine, and what I conceive to be the peculiar advantages of the American engine.

It is well known, that the crank-shaft, and the wheels, of the locomotive engine, have been by far the most troublesome and expensive part of the machine to be kept in repair. By the improvements in Mr. B.'s engine, these difficulties have been obviated, as has been proved by experiment. Of the 7 engines on the state road, and 2 on the Trenton road, some have been at work since the 1st of July last, and in no instance has a

crank broken, or worked loose, or any of his improved wheels failed, or given trouble.

It is here proper to observe, that the Pennsylvania road is almost a continued series of curves, ranging from 500 to 700 feet radius, and so severe is it upon the wheels of an engine, that one of the English engines, (the other having been out of repair most of the time,) has within 2 months used up or destroyed a part of the wheels of both engines, and is now using a set of Mr. Baldwin's wheels.

The other improvements affect the force-pump, eccentrics, and reverse gear, all of which are so much simplified that the joints and working parts are not more than half as numerous as in the common English engine. The steam pipes have all ground metallic joints, and no cement or soft solder is used in any of the joints of the engine.

Another very important improvement has been added, by which the adhesion of the driving wheels may be increased at will, from 35 to 50 per cent. By this means, one of these engines, with only 6487 lbs. on her driving wheels, as a fixed weight, has carried a gross weight of 80 tons up an inclination nearly two miles in length, of 35 feet per mile ascent, without any perceptible slipping of the wheels.

The great object of the whole of these improvements has been to strengthen the weak points in the machine, and to simplify and reduce the number of its parts; and so fully has this object been accomplished, that this engine may justly be considered the most perfect of its kind now in use.

A FRIEND TO AMERICAN MANUFACTURES.
New-York, June 16, 1835.

[From the American Railroad Journal.]

We have been again favored by Mr. G. RALSTON, of Philadelphia, now in London, with an interesting letter, from which we make the following extract; and we take this method of returning our thanks for the numerous favors conferred upon us and our readers, by Mr. Ralston, in forwarding early accounts of improvements in the construction of railroads and railroad machinery. He will please to accept our especial thanks for the Report of Dr. Barlow, "on the transverse strength and other properties of malleable iron," of which we shall endeavor to give a full account in our next number; and also for the papers on "Pneumatic Railways," one of which, containing the opinions of Professor Faraday and Dr. Lardner, will be found in this number.

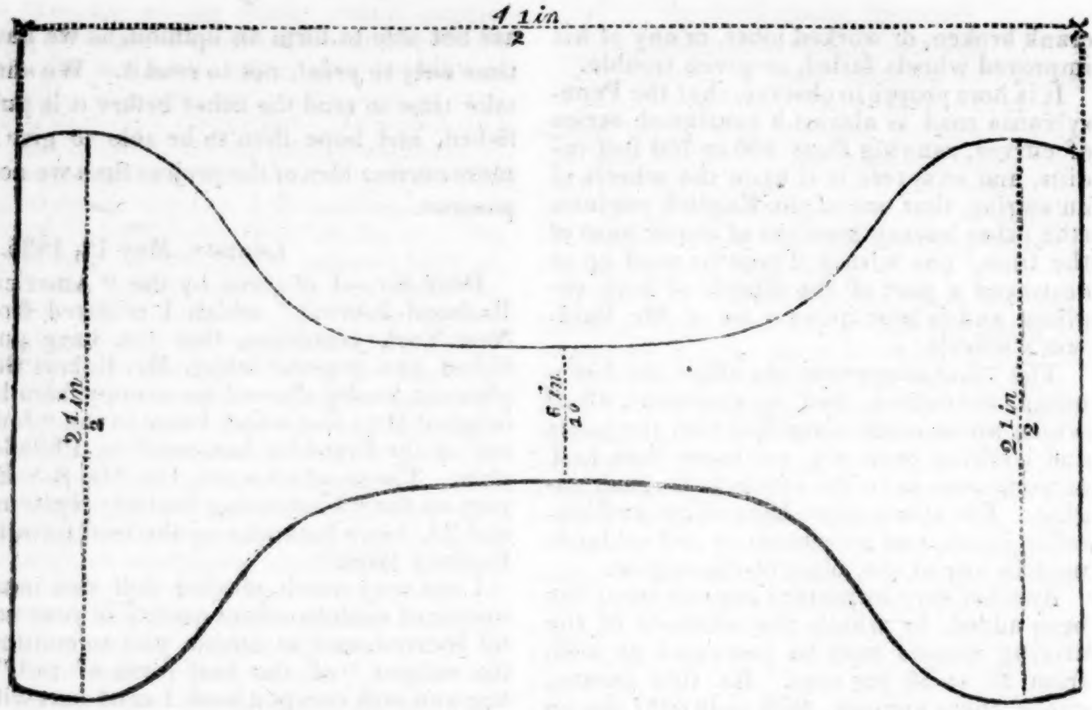
Of this "new plan" we confess that we are not able to form an opinion, as we have time only to *print*, not to read it. We shall take time to read the other before it is published, and hope then to be able to give a more correct idea of the project than we now possess.

LONDON, May 12, 1835.

Dear Sir,—I observe by the "American Railroad Journal," which I received from New-York yesterday, that you have published two papers* which Mr. Robert Stephenson kindly allowed me to copy from his original MS., and which I sent to the "Journal of the Franklin Institute" in Philadelphia. These articles are, 1st, Mr. S.'s Report on the "Undulating Railway System," and 2d, his "Remarks on the best form for Railway Bars."

I am very much pleased that you insert matter of such excellent quality in your useful Journal, and to enable you to continue the subject "of the best form of rail," I beg you will accept a book I send herewith, being a Report and Appendix made by Professor Barlow to the London and Birmingham Railway Company on this subject. You will observe that he controverts Mr. Stephenson's arguments in favor of "fishbellies," and gives a decided preference to parallel rails. I think this report will please your numerous readers. I must call your attention to the circumstance that, on the Liverpool and Manchester Railway, they are now taking up (as rapidly as is convenient) the fishbellies of 35 lbs. per yard, and laying down in their place parallels of 60 lbs. per yard. You know the increase of weight of locomotives on this road is very considerable; they formerly weighed 4 or 5 tons—they now weigh 10, 11, and 12 tons. So also on the Stockton and Darlington Railway, the rails originally weighed 28 lbs. per yard; they have removed them, and substituted rails of 45 lbs. per yard. On all the railways in use, or being constructed in this country, they consider heavier locomotives, and of course stronger rails, as most expedient and economical. Enclosed I send you a tracing of the new rail for the "Grand Junction Railway," (from Birmingham to Warrington, to make the connexion, by railway, from London to Liverpool.) [See accompanying figure.] You will observe that it is a parallel rail, of 60 lbs. per yard, and that it is somewhat in form of Mr. Robert Stevens's (our distinguished countryman) T rail—having as much base, which rests upon the ground, as surface for the wheel to run upon. The Engineer of this railway is Sir George Stephenson, (lately knighted by the King of the Belgians,)

* See Mechanics' Magazine, vol. v., pp. 169, 269.



the father of Mr. Robert Stephenson, who is the Engineer of the Birmingham and London Railway. These two eminent men being in habits of constant intercourse, I think it highly probable that this form of rail has been adopted with the sanction of both of them; and if it be so, the fishbellies will never come into favor again.

I also send you two papers on the "Pneumatic Railway System," contrived and patented by our countryman, Mr. Pinkus, of Philadelphia. The shares for the Company have all been taken with great eagerness, and a line of a few miles in length is to be immediately laid down near London, for the purpose of testing its practicability and utility. The members of the association, as well as many others, are very confident of success; but we shall soon see whether it will answer as well in practice as it promises in the working model.

I am very much pleased that you advocate with so much ability and zeal that magnificent project, a railway from the Hudson to Lake Erie. I read your articles with deep interest, and hope your judicious exertions will be crowned with success. As I am in the midst of railway iron, locomotives, and persons connected with all projects of internal improvements, I will be happy to serve you, or the readers of your excellent Journal, by procuring information, or in any other way that may be pointed out to me as acceptable.

I am, very respectfully,
Your most ob't serv't,
GERARD RALSTON.

Opinions of Prof. Faraday and Dr. Lardner upon the Pneumatic System of Railway.

Royal Institution, 3d Feb., 1835.

My dear Sir,—The points in your letter of the 26th of last month, which you put to me for an opinion, are such that I have no hesitation in agreeing with you upon them.

To enumerate briefly these points:—the *principle* of communication of power is correct; the use of local steam engines is highly advantageous, both for cheapness of force and capability of varying it when required; the necessity for levels will, I presume, therefore be greatly obviated; the association of cylinder and rails is such, that the whole road must (with sufficient thickness in the cylinder) have great strength and firmness; the absence of locomotive engines removes much of the cause of derangement which the road would have to sustain; and I do not see how the governor and carriages can leave the railway.

You know my objection to giving a general opinion in reference to the profitable application of the plan in question; but I may here add, that the reserve I feel originates simply in my possessing no practical knowledge of the construction, expense, and profit, of ordinary railroads.

I am, my dear Sir, very truly yours,
M. FARADAY.

Wm. Hosking, Esq., F. S. A., &c.

—

I have read the specification of the patent for the pneumatic railway and the accompanying papers, and have also examined

the drawings and models which have been submitted to me by Mr. Hosking.

Two methods have been heretofore employed for rendering steam power available in transport upon railways; one by causing a travelling or locomotive engine to move with the load which it draws, the other by constructing, at intervals of about a mile and a half, stationary steam engines, the power of which is transmitted to the load by a rope carried along the road upon rollers or sheaves placed between the rails. The train being attached to this rope, is drawn by the power of the engines from station to station. The object of the pneumatic railway is to substitute for the rope a partially-exhausted tunnel; to employ the fixed steam engines to work air-pumps, by which a rarefaction of the tunnel shall be maintained; and to cause the trains to be tracked upon the railway by connecting them with a diaphragm or piston placed in the interior of the tunnel, so as to have that part of the tunnel in advance of the piston rarefied by the engines, while that part behind the piston is open to the atmosphere. An effective impelling power is thus obtained equivalent to the difference between the pressure of the atmosphere on one side of the diaphragm and of the rarefied air on the other.

Of the practicability of this project I think there can be no doubt. The working of large air-pumps by an adequate moving power, and the rarefaction of air in tubes or tunnels by such means, is not a new idea. It was suggested by Papin, in the latter end of the seventeenth century, and was even pointed out by him as a means of transferring power to a distance, without the loss by friction and other causes consequent upon the use of ropes or other ordinary means of transmitting force.* It is, in fact, a well understood principle in physics, that whatever moving force be expended in producing the rarefaction of air in a cylinder or tunnel, must necessarily be followed by a corresponding force on the other side of a diaphragm moving air-tight in that tunnel, and exposed to the free action of the atmospheric pressure. In the present case, supposing the structure of the valvular cord and the pneumatic piston to be perfect, the opposite side of the diaphragm will always be pressed by an effective impelling force, the amount of which may be calculated upon these principles. It will of course be perceived that no original moving power is obtained from the tunnel, or from the rarefied air; the rarefaction gives back the power expended by the stationary engines and nothing more; and the tunnel must therefore be regarded merely as a substitute for the ropes in the common method of working railways by stationary engines. But it is evidently attended with several advantages in comparison with the latter. A very large proportion of the moving power of stationary engines worked by ropes is intercepted by the resistance from the weight and friction of the ropes, sheaves, barrels, drums, &c. All such waste of power is removed by the pneumatic tunnel.

The original expense of ropes and their wear and tear would be likewise saved. Some notion of the extent of this saving may be collected from the following facts: when the Liverpool and Manchester railway was about to be brought into operation, a question arose as to the expediency of working it by stationary engines, and estimates of the expense were made by competent engineers. The total amount of capital to be invested in moving power was estimated at about £120,000; of this above £25,000 was devoted to ropes, sheaves, drums, and other necessary accompaniments. The total annual expense of maintaining the moving power was estimated at £42,000, and of this about £18,000 was appropriated to the wear and tear of ropes, sheaves, &c. Thus it appears that the method of transmitting the power of the stationary engines to the trains by ropes would absorb about 20 per cent. of the invested capital, and their maintenance would consume about 43 per cent. of the annual expenditure.

Another source of comparative economy would obviously be the diminished number of stationary engines. In the estimate already referred to, it was calculated that the distance of 30 miles should be divided into 17 stations, with two 40 horse engines at each station; besides these there would have been two engines at the bottom of each inclined plane, one at the tunnel, two at the top of the planes, and one at the Manchester end, making in all 42 stationary engines to work a line of 30 miles. Now, according to the estimate of the patentee of the pneumatic railway, from three to six stations would be sufficient between Manchester and Liverpool, and the whole line would be worked by from six to twelve steam engines. Putting aside therefore the saving of power which would arise from the substitution of suction in the tunnel for ropes, and supposing the amount of stationary power in both cases to be the same, it will be evident that a material saving would arise from the circumstance of that amount of power being derived from so much less a number of engines,—the number of engine-

* Papin proposed to obtain an active force at one end of an extended tube by the application of water power at the other.—W. H.

men, assistants, &c., besides the interest on capital, being considerably less.

Some notion of the economy of power likely to arise from superseding the use of ropes may be collected from the result of experiments made by Messrs. Stephenson and Locke on the resistance arising from the friction of ropes. They found that a load of 52 tons drawn by stationary engines worked by ropes through mile and half stages, offered a total resistance amounting to 1156 lbs.; of this 582 lbs. arose from the friction of the load, and 574 lbs. from the friction of the ropes. In the case of the pneumatic railway, the friction of the rope is replaced by the friction of the air-pumps and of the impelling apparatus, and it will be evident that the latter, compared with the former, must be almost insignificant. Hence the power wasted in its transmission from the stationary engines to the load, which in one case amounts to 50 per cent. of the whole moving power of the engine, in the other is of comparatively trifling amount.

Slopes on railways will always be objectionable whatever power be used; for even the most gentle ascent will increase the resistance of the load in an enormous proportion. The difficulties, however, which they present are materially less when the line is worked by stationary than by locomotive engines, and would be still further diminished by superseding the rope; the resistance arising from the rope being always greater on inclined planes than on the level, owing to its increased thickness and consequent weight. A load which requires a 4½ inch rope for the level requires a 5½ inch rope upon a slope of 1 in 100. The weights of equal lengths of these ropes would be in the proportion of about 2 to 3, the slope requiring one-half more weight of rope than the level. Besides this, the moving power on a slope, in addition to the ordinary friction which it has to overcome on the level, has likewise to draw up the weight of the rope, —a resistance which will be increased in proportion to the acclivity of the slope.

The disadvantages produced by slopes when locomotive engines are used are still more formidable. The same engine which is fitted to work upon the level is altogether inadequate for the slopes, the consequence of which is, either that the locomotive is strained beyond its power by working up the slopes, and rapidly destroyed, or that the engines must be more powerful than is requisite for the common level of the road, and thus power and expense wasted; or finally, that an auxiliary engine must be kept constantly ready at the foot of each slope, with its fire lighted and its steam up, ready to help up the trains as they arrive. Unless the trains be almost incessant (which, even on the most frequented railroad, they never can be,) this last expedient, which is the one adopted on the Manchester line, is attended with great waste of power and expense. Stationary engines worked on the pneumatic principle would effectually remove all these difficulties and objections.

The weight of the trains which could be drawn upon the pneumatic railway, and the speed of the motion imparted to them, would entirely depend upon the power of the stationary engines. As the friction or other resistance does not increase with the velocity, the same absolute expenditure of power would draw the same load at whatever speed. The high speed attained by locomotive engines has been attended with great expense, but this has not arisen from the increased expenditure of power. It has been caused by the wear of the egines themselves, consequent on their rapid motion on the road, and by the necessity of sustaining a fierce temperature in the fire-place, in order to be able within the small compass of these engines to generate steam with sufficient rapidity to attain the necessary rate of motion. As the magnitude of the stationary engines would not be limited, and as they would not be subject to the injurious effects of motion on the road, steam could be produced in sufficient quantity for the attainment of any required speed, without increasing its cost, or in any way impairing the machinery.

One of the obstacles to the attainment of great speed by stationary engines worked by ropes, is the delay produced in transferring the trains from engine to engine, and from station to station. The momentum imparted to them is lost at each change, and these changes occur every mile and a half, so that the train has scarcely attained its requisite speed, when its motion must again be checked in order to hand it over to another engine. This difficulty is removed by the pneumatic system: there being no rope to be detached and attached, the engine passes on by its momentum from station to station, and a contrivance is provided by means of a valve at the stations, by which it is brought under the operation of the next engine without stopping its motion.

Although the danger of accidents to passengers on the present railways worked by locomotive engines is considerably less than that of travelling by horse coaches on turnpike roads, yet serious accidents have occasionally occurred. These have generally arisen either from the locomotive engine running off the rails, from one train running against another, from the locomotive engine breaking, or, finally, from persons standing

upon the rails being run down. In the pneumatic system there is almost a perfect security from these causes of danger. From the engines being stationary, and the tunnel rising between the wheels of the trains, it is evidently impossible for the carriages to run off the road; and from the manner in which the system is worked, it is impossible that one train can run against another. It happens also that the nature of the rails themselves, forming, as they do, merely ledges upon the sides of the tunnel, prevent the possibility of persons standing between or upon them.

In railways worked by stationary engines, serious accidents have occasionally occurred by the ropes breaking, while the train has been ascending a slope. In such cases the train has run down by its weight with a frightful rapidity, producing the destruction of the carriages and the loss of life. It is evident that this source of danger is removed by the pneumatic system.

An advantage possessed by this system above the edge railroad, deserves to be particularly noticed. In the edge railroad, the engines and carriages are kept upon the road by flanges, or ledges, raised upon the tires of the wheels, which press on the interior of the rails. Every thing which causes the carriages to press on the one side or the other, causes these flanges to rub against the rails. When a curve or bend happens in the road, the carriages are guided by the pressure of one or the other flange on the side of the rail, which of course is accompanied by considerable friction. In the pneumatic railway there are no flanges, either on the wheels or rails; the carriages are guided by wheels, or rollers, placed in a horizontal position, and acting upon the external sides of the channel which receives the valvular cord. By this means all resistance which arises from what is called rubbing friction, is removed, and every surface which moves upon another, moves upon it with a rolling motion.

It is well known, that notwithstanding the prosperous condition of the Manchester Railroad Company, yet their expenditure in locomotive power has been so enormous as to cause considerable anxiety on the part of the managers, and some of them have even inclined to the opinion, that the question of stationary power deserves to be reconsidered. This opinion would probably be confirmed and strengthened, if the practicability of the pneumatic system were satisfactorily demonstrated by experiment upon a sufficiently large scale.

On the whole, it appears to me that if the mechanical difficulties of maintaining the pneumatic tunnel sufficiently air tight be overcome, the system presents a fair prospect of being practically successful. **These difficulties are not so great as they may at first appear. It should be recollected, that nothing approaching to the *exhaustion* of the tunnel can be necessary; nor even any considerable degree of rarefaction. Supposing the tunnel to have an internal diameter of 40 inches, the impelling diaphragm would have a surface of about 9 square feet.** If in such a tunnel a degree of rarefaction were produced, sufficient to cause a barometric gauge to fall two inches, (which would be an extremely slight degree of rarefaction indeed,) an impelling force would be obtained amounting to one pound on every square inch of the suriface of the diagram, which would give an mpelling force of more than half a ton. It is calculated, that on the common railways the amount of load is above 200 times the force of traction, and it would therefore follow, that this force would be sufficient to draw a load of 100 tons. If an additional inch of mercury be made to fall in the barometric gauge, to balance friction, &c. still the rarefaction would be extremely inconsiderable, and the contrivances to prevent leakage would appear to be attended with no great mechanical difficulty.

From the various reasons which I have above stated, I am of opinion that the present project would, if carried into execution, be likely to be attended with greater economy and safety than any other method of working railways now practised; and I see no reason against the attainment of as much speed as is obtained by the locomotive engines. At all events, having explained the reasons on which I have grounded this opinion, every one can judge to what weight it may be entitled. The project would appear to be well deserving of trial on some railroad of limited length, such as that between London bridge and Greenwich, where it would be sufficient to have stationary engines at the extremities. In such a case, I see scarcely any limit to the speed which might be attained with safety; and the economy, as compared with locomotive engines, would probably be very great. DION. LARDNER.

London, Feb. 19, 1835.

EXPERIMENTS TO PRODUCE LIGHT IN WATER.—An experiment, to ascertain at what depth a white object might be visible in the sea, has just been made by a gentleman who has devoted much time and attention to extend the bounds of science. Having let down a metal plate, painted with white lead, he was able to distinguish it by moonlight at the depth of forty feet; while, by that of the sun, he lost sight of it at about eighty feet. The difference must

seem surprising when we compare the intensity of the two lights — that of the sun being, according to Bougner, *three hundred thousand times* stronger than that of the moon; but the dazzling which affects the eyes by the corruscation of the solar rays, does not allow us to be sensible to feeble impressions on the visual organs. Any instrument, therefore, which should enable us to see at great depth under water would be exceedingly useful, either in recovering any object that might be lost, or in constructing submarine works in sea-ports. A method used by fishermen to obtain this advantage consists in pouring oil upon the water, to make it more transparent. In the bay of Naples it is constantly practised by the fishermen at night. Their boats are provided with a composition which gives an intensely vivid flame, and is placed out at the stern. Attracted by the light, the fish follow it from every direction, keeping near the surface, and hovering around it like moths. They are then easily captured, after being struck or harpooned by four-pronged spears. Those who search for shell-fish (frutti di mare) in the day-time, near the shore, employ the same method, throwing little pebbles steeped in oil before them. The gentleman, who was acquainted with this simple contrivance, wishing to ascertain its efficacy, poured a small quantity of oil on the sea, and was thereby enabled to distinguish shells and other objects which had not been visible to him before. When oil is thrown on the surface of water which is not confined by banks, the coast extends itself to a great distance, becoming thinner and thinner, until it can no longer be distinguished separate from the water. The effect of the oil is, apparently, to draw off, as it spreads, those little objects which prevent the transparency of the water by floating on its surface. All the experiments hitherto made, tend to corroborate this assertion; one of them in particular is very conclusive. Half a spoonful of olive oil having been poured near the edge of a large oval sheet of water, on which the wind had blown a quantity of acacia flowers, it was observed, that, in a few seconds afterwards, one half of the surface was completely swept of these floating flowers, and that they were all collected on the opposite part. Similar experiments are still in progress.—[Literary Gazette.]

The Menai Bridge.—A friend of ours, who lately crossed this bridge, was informed by a gentleman who resided close to it, and has erected standards by which to mark the degree of vibration to which it is subject, that during the late violent gales it was on several occasions so much agitated as to oscillate to the extent of eight feet six inches—that is, four feet three inches both ways, out of the straight line. We believe, however, that even a much greater rate of oscillation than this was allowed for in the calculations on which it was constructed.

[From the London Mechanics' Magazine.]

DESCRIPTION OF THE FREYBURG SUSPENSION BRIDGE.

Translated from the German, by J. E. Terry, C. E.

The city of Freyburg, in Switzerland, is well known to most travellers for its remarkable locality, being seated partly in a deep and winding valley, watered by the river Saone, and partly on the adjacent high and overhanging cliffs. To arrive at the centre of the town, by the road from Berne, carriages were formerly obliged to descend the steep declivity of the Staalberg. On arriving at Bernegate, it seemed to travellers as if they had already got to the end of their journey, but great was their astonishment to be informed that they had yet to travel for half an hour before they could reach the city—to follow the several large windings of the river, cross it three times, then to ascend the long, difficult, and steep ascent called *Alt Brunnen Strasse* (Old Well-street), which was at all times enough of itself to dismay a traveller, and has proved the death of many a horse. The bad state of the roads, and defective plan of the streets leading to the centre of the city, increased the difficulty of approaching it. Industry, commerce, social life, all felt alike the influence of this almost isolated position of the place. But what could be done? The obstacles seemed insurmountable; the almost perpendicular cliffs on which the chief part of the town stands, seemed to mock the idea of forming a street through them of any tolerable degree of ascent; and had even this been possible, it would only have tended to increase the length of the windings. On the other hand, the idea of erecting a bridge, either of wood or stone, of a sufficient height to overcome the difficulty of the rugged ascents and descents, seemed too daring for contemplation, the height being upwards of 150 feet, and the length much greater. The expense, too, espe-

cially if stone had been employed, would have been out of all proportion to the means of the citizens; for the city is not rich, being but little frequented, and thinly populated, containing, exclusive of the suburbs, no more than 9,000 inhabitants.

Some of the more public spirited and zealous citizens, who had heard of the iron suspension bridges erected in other countries, at length proposed to raise, by subscription, the pecuniary means necessary for ascertaining the applicability of such a structure to the natural circumstances of Freyburg, and, if practicable, of actually constructing it.

As soon as the subscription reached a suitable amount, several eminent engineers were consulted, and after examination of the plans of different competitors, M. Chaley, the famous French engineer, who erected the wire bridges at Beaucaire, Chasey, and several other places in the south of France, obtained the preference. The contract agreed on with him on the 10th February, 1830, was to this effect: that he was to have, at different instalments, 200,000 (Swiss) francs, for the completion of an iron wire bridge; that the expense of the approaches on both sides, and the compensation to individuals for loss sustained in their property, should be defrayed partly by the subscribers and partly by the government; and that the contractor, M. Chaley, subject to certain conditions, should have the enjoyment of the produce from the tolls for 80 years. Some time afterwards, these conditions were considerably modified; it being agreed that M. Chaley's right to the tolls should be limited to 40 years, at the end of which time, the profits are to revert to the subscribers during 59 years, after which the toll is to cease, and the bridge to become the property of the canton, or common property.

The first general meeting of the subscribers took place on the 19th of March, 1830, when they appointed a committee of 10 members (afterwards increased to 20) to superintend the erection of the bridge.

Immediately after these arrangements, the necessary preliminary preparations were entered upon; but the political disturbances which broke out, in 1830–1, in France, and afterwards in Switzerland, but particularly in the canton of Freyburg, had a most injurious influence on the undertaking—added to which, differences arose between the contractor and the committee, which tended greatly to retard the project. The general good will of the citizens, however, and the indefatigable zeal and activity of some of the leading members of the committee, re-called ere long the dormant project into life and activity. In March, 1832, the works were entered upon with great zeal, and the first stone of one of the porticos was laid, under the superintendence of the architects Kraser and Brugger. From that time the works were continued in every department without interruption; and, to facilitate their progress, a temporary bridge was thrown over the river Saone, it being for the ease and advantage of the workmen to get from one side to the other without loss of time.

The finances of the company were all expended, however, long before the bridge approached to its completion. But though the funds were exhausted, the ardor and generous feeling of the subscribers and donors were not. Government, which, from the beginning, had given its particular sanction and protection to the measure, came once more to its assistance, by granting leave for the opening of a lottery, which produced to the company the sum of 80,000 francs.

The work was now once more renewed with vigor, and on the 9th of June, 1834, the subscribers had the gratification of seeing extended across the valley, the first of the numerous wires which form the two main ropes or supports of the bridge. Next followed the fixing of the subordinate suspension wires, and the laying down of the beams to form the foundation or flooring of the bridge. The latter mentioned operation took place, it might be said, in a magical manner. The inhabitants were not a little surprised to find at their gates an unlooked-for, and, for foot passengers, a sufficiently solid bridge, where, ten days before, they had seen only two immense wire-ropes. After this, the other various inferior works soon followed, as the completion of the footway, the erection of the balustrade, &c. At length, on the 8th October, a carriage was driven over the bridge at full gallop, which was followed, on the same day, by the stage, or post coach, from Berne to

Freyburg, enthusiastically greeted by a vast number of astonished spectators.

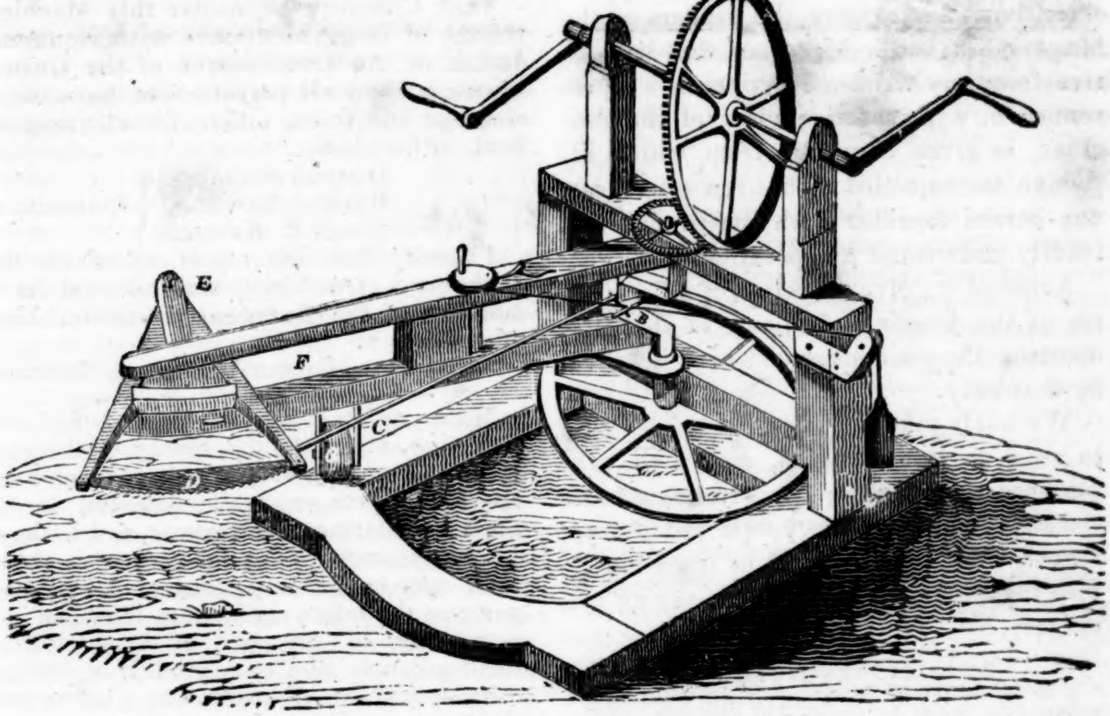
The balustrades, though simply modelled, present, nevertheless, a very handsome appearance. Any vehicle, be it ever so heavily laden, may safely venture over; and although the ear is at first rather startled at the noise of the trampling of horses, yet the most clear-sighted person cannot discover the slightest motion communicated either to the wire ropes or to any other part of the bridge. The traveller passing over does not feel the least vibration, and his astonishment finds no bounds, to think that he has arrived so soon, and in safety, across the deep gulf below.

As has been before observed, the whole structure is suspended by two large ropes of wire, firmly secured at each end, by being let into shafts made for that purpose. At each end the porticos, over which the ropes pass, serve for antagonist supporters, or counterforts. They are built partly of limestone, brought from Neuenberg and Neuenstadt, and partly of sandstone, which is got in the stone quarries in the neighborhood of Freyburg: all the blocks are, by way of greater security, connected with each other by means of iron cramps. The quantity of iron used for this purpose was 570 cwt. The height of the porticos is 65 Berne feet. The opening for the gateway is 45 feet high, 20 feet wide, and 19 feet in depth; the width of each pillar is 14 feet. About 160 feet from the porticos the shafts are situated; their depths are each 58 feet, and their diameters 32 feet. These shafts are hewn out of the rock on both sides, and comprise each three chambers, situated at a certain distance from each other, each containing three immense unwrought blocks of Neuenberg stone, to which the main wire ropes are fastened. The connecting wires or chains, 16 in number, are drawn through these vaults; they rest at the same time on 12 cast iron cylinders, and are held fast by 128 anchors or grapples, of a total weight of 1,024 lbs. These connecting ropes or ties serve the great main wire ropes as auxiliary supports, which bear up on both sides the great beams of the bridge flooring, by means of suspension wires or ties. The length of the main wire ropes is 1,280 feet each. They consist each of 2,000 separate wire threads, which united make a mass of 4,000 threads, or little chains, of a total weight of 960 cwt. Dependent from each of the two main connecting wire ropes, or inverted arch, hang 164 smaller suspension wire ropes, at about 5 feet asunder: these are made fast above through iron loops, and below are connected with hoops of iron, into which the beam ends which support the footway are firmly fastened. The longest of the smaller dependent ropes of wire is 60 feet, and the shortest half a foot; each is composed of 25 single wires, so that the roadway of the bridge is held up by more than 8,000 single wires. The number of beams which form the foundation or platform of the bridge, amounts to 166, held together by 328 hoops of wrought iron. Four lines of beams run longitudinally throughout the whole length of the bridge, upon which rest the two footways. On both sides, to separate the carriage-way from the foot-paths, are strong oaken balustrades, made in the form of St. Andrew's cross, the height of which is 4 feet. The carriage-way is 16 feet, and each footway 3 feet, wide: so that the total width of the bridge is 22 feet. Its total length, including the two counterforts, over which the main wire ropes are passed, is 941 feet; exclusive of the counterforts, its length is 903 feet; the carriage-way alone is 864 feet. Its height above the river, when measured 30th Oct. 1834, was 163 feet.

The quantity of iron used in this work was not less than 80 tons, and of wood 135 tons.

The weight sustained by the two main wire stays is 120 tons; and it is calculated to sustain the amazing and enormous weight of 2,400 tons. J. E. T.

Felling Trees by Machinery.—Mr. James Hamilton, of this city, the inventor of a machine for *sawing* and *boring* for mechanical and other purposes, and for which he obtained a patent as well in England, Ireland, Scotland, and France, as in the United States, has recently invented a machine for *felling trees* in the forest, in which he has succeeded even beyond his most sanguine anticipations; and which will, I have no doubt, prove a valuable labor-saving machine to the settlers of new



References—A, principal wheel, to which the power is applied; B, perpendicular shaft; C, rod connecting the saw with crank shaft; E, pivot on which the saw vibrates; F, frame, revolving on perpendicular shaft, which supports the saw; G, small roller, between the saw frame and the front sill of the machine, to support and keep the saw level.

countries, and even where it is partially settled.

This machine requires very little more space for use, than is required to swing an axe; and it may be used in almost any situation where a man can use an axe. It may be moved by one man, from tree to tree, with great facility, (although two men will work it to better advantage,) who can cut a tree of 20 to 24 inches diameter in five minutes, and larger ones in proportion. The machine is so constructed as to admit the use of a saw of 3, 4, 6, or even 9 feet in length, according to the size of the tree.

Such is the construction of the machine, and it may be considered as one of its peculiar qualities, that the more rapid its motion, the less power is required to keep it in motion—or, in other words, by the use of a horizontal fly-wheel, which is placed near the ground-sills of the frame, the machine may be made to perform 250 to 300 strokes per minute, each of which shall cut upon an average at least 1-20th of an inch, or at the rate of 8 to 12 inches per minute, on an ordinary sized tree—thereby producing great execution with very little labor.

The simplicity of this machine is such that there is little danger of its getting out of order; and ample means are provided to prevent accidents from the falling of the trees.

However great may be the advantage of this machine for ordinary use, or for clearing of land for cultivation, in the saving of time, it will be found even more valuable for the purpose of cutting trees for timber; as it will always leave a square and uninjured but, and save the labor and loss of timber; which always results from squaring the end when chopped in the usual mode. In cutting mahogany trees especially, the most valuable part of which is near the root, it will be found of great value. Mr Hamilton is certainly entitled to much credit for his efforts to facilitate this, the first and most laborious part of the husbandman's labors. None but those who have had experience can appreciate the toil of this labor in a new country; none therefore but such, and

not even those until they have used it, can appreciate the va of this invention. In order, however, to give the readers of the Magazine a better idea than they can derive from any written description, a representation, a perspective view of the machine, is given herewith, from which, although accompanied by but few references, any person familiar with machinery will readily understand its operation.

Annexed we give the report of a Committee of the American Institute of this city, showing the estimation in which it is held by that body.

We shall take occasion hereafter again to refer to this machine, and shall take pleasure in recording its performances for the benefit of both the public and the patentee, who deserves well of his countrymen for his inventions of labor-saving machinery.

AMERICAN INSTITUTE, Clinton Hall,
City of N. York, June 25, 1835.

The Committee to whom was referred the improved Machine, invented by Mr. James Hamilton, of this City, for felling trees, report:

That this invention of Mr. Hamilton is one of great public utility, not only in clearing land of trees, but in felling timber trees for naval and civil architecture.

It cuts the stumps uniformly of an equal height, and at least 12 or 16 inches closer to the ground than is usual, the stumps being left with a horizontal surface; having been cut with a saw, and absorbing more moisture than when cut with the axe, the stumps will decay much faster.

Much of the most valuable part of the timber also is saved in cutting close to the ground, and the end of the timber is square when felled, thus saving the additional time and trouble necessary, in the ordinary way of felling, to prepare it for the mill by butting.

The Machine is simple in its construction, and may be worked by one or two men. It can be built for about $50. *It is believed that two men may fell by this machine as much in a given time as twenty can by the ordinary way.* Sufficient provisions are made to prevent the tree from falling on the machine, and to prevent the saw from being pinched.

A tree of 2 feet diameter can be cut with it in five minutes by the power of one man, and with a saw proportionally larger, trees of any magnitude may be cut with ease. This Machine is about three feet wide and four feet long, and is easily moved from tree to tree, as it runs on small wheels.

Your Committee consider this Machine worthy of being mentioned with commendation to the Government of the United States, and to all persons who have occasion to fell trees, either for clearing of land, or for timber.

GEORGE SULLIVAN,
ROBERT NEWELL,   Committee.
JAMES F. KENNEY,

I certify that the report, of which the above is a true copy, was adopted at a meeting of the American Institute, June 25, 1835.

EDWIN WILLIAMS, Rec. Sec.

MODE OF PRESERVING MILK FOR LONG VOYAGES.—Sir: As the season of the year is now arrived when hundreds of mechanics are induced to cross the Atlantic, in the hope of bettering their fortune, and to those who may carry young families with them, milk may be an important article of diet, perhaps the following extract from an old newspaper of the date of 1822, setting forth a simple and easy method of preserving it, may be of importance; more particularly as I perceive from your last monthly list of new patents, that a method of preserving animal milk has just been patented—whether the same or a different method remains to be seen:

"Provide a quantity of pint or quart bottles (new ones are perhaps best;) they must be perfectly sweet and clean, and very dry before they are made use of. Instead of drawing the milk from the cow into the pail as usual, it is to be milked into the bottles. As soon as any of them are filled sufficiently, they should be immediately well corked with the very best cork, in order to keep out the external air, and fastened tight with packthread or wire, as the corks in bottles which contain cider generally are. Then, on the bottom of an iron or copper boiler, spread a little straw; on that lay a row of the bottles filled with milk, with some straw between each, to prevent them from breaking, and so on alternately until the boiler has a sufficient quantity in; then fill it up with cold water. Heat the water gradually until it begins to boil, and as soon as that is perceivable draw the fire. The bottles must remain undisturbed in the boiler until they are quite cool. Then take them out, and afterwards pack them in hampers, either with straw or sawdust, and stow them in the coolest part of the ship. Milk preserved in this way has been taken to the West Indies and back, and at the end of that time was as sweet as when first drawn from the cow."

I am, Sir, yours, J. ELLIOTT.
March 30, 1835.

[From Transactions of the Essex Agricultural Society.]

ON COLORING.

The art of fixing on cloths beautiful colors, although not one of the most necessary, has been made by the fashions, taste, and pride of men, in all ages and nations, one of the most valued of inventions. It is altogether a chemical art. Its theory is now well understood, and is in a high degree interesting to every studious mind, useful to all engaged in manufacturing, or in buying, selling, or consuming colored fabrics. It is, therefore, worthy the attention of all our readers.

Colors, to be permanent, must be combined with the fibres of the silk, wool, cotton, or linen, of which the cloth is composed. To understand how this can be effected, we must acquaint ourselves with the laws of chemical affinity. Affinity is nothing more than the disposition or tendency which two or more substances have to unite and form a new compound, differing greatly in some of its qualities from the simple substances of which it is composed; one substance is therefore said to have an affinity for another when, on being brought in contact, it unites with and assumes new appearances and qualities. For example, if iron and sulphuric acid (oil of vitriol) be brought together, they gradually unite and form sulphate of iron (green vitriol or copperas), but the sulphuric acid has a stronger affinity for lime than it has for iron; if, therefore, lime be brought into contact with sulphate of iron, the sulphuric acid quits the iron, seizes on the lime, and forms sulphate of lime (plaster of Paris.) Substances used in dyeing possess an affinity for the fibres of the cloth, and when dissolved in water or some other liquid, and brought into contact, they unite, and change either the color of the fibres, or so change their qualities, as to dispose them to unite with other coloring matter for which before they had no affinity.

The art of dyeing, then, consists in combining a certain coloring matter with the fibres of the cloth. This process cannot be well performed unless the dye-stuff be dissolved in some liquid, and the particles so separated that their attraction for each other becomes weaker than the attraction for them exerted by the cloth. When the cloth is dipped into this solution, it attracts the coloring matter, and from its stronger affinity takes it from the solvent and fixes it upon itself. The facility with which cloth imbibes a dye, depends on two circumstances, namely, the affinity between the cloth and the dye-stuff, and the affinity between the dye-stuff and its solvent. It is of importance to preserve a due proportion between these two affinities, as upon that proportion much of the accuracy of dyeing depends. If the affinity between the coloring matter and the cloth be too great, compared with the affinity between the coloring matter and the solvent, the cloth will take the dye too rapidly, and it will be scarcely possible to prevent its color from being unequal. On the other hand, if the affinity between the coloring matter and the solvent be too great, compared with that between the coloring matter and the cloth, it will either not take the color at all, or take it very faintly. Wool has the strongest affinity for most coloring matter, silk the next strongest, cotton a much weaker affinity, and linen the weakest of all. In order, therefore, to dye cotton or linen, the dye-stuff should, in many cases, be dissolved in a liquid for which it has a weaker affinity than for the solvent employed in dyeing wool or silk. Thus we may use iron dissolved in sulphuric acid to dye wool, but for cotton and linen it is better dissolved in vinegar. Was it possible to obtain a sufficient variety of coloring matters having a strong affinity for cloth, the art of dyeing would be exceedingly simple and easy. But this is by no means the case; if we except indigo, the dyer is scarcely possessed of a dye-stuff which yields of itself a good color, sufficiently permanent to deserve the name of a dye. To obviate this difficulty, some substance must be employed which has a strong affinity both for the cloth and the coloring matter. Substances employed for this purpose are called mordants. Those chiefly used are earth, or metals, in the form of salts or in solution, tan, and oil.

One of the most frequently used is *alum*. This salt is composed of pure clay (alumina) dissolved in sulphuric acid. Into a solution of alum the cloth is dipped: the fibre of the cloth having a stronger affinity for the clay than the sulphuric acid has, unites permanently with it. It is then taken out, washed and dried, and will be found a good deal heavier than before, although the color remains the same, the clay, which now forms a part of it, being perfectly white. The cloth may now be dyed by dipping it in a solution of any coloring matter for which the clay has a strong affinity. The clay and coloring matter may be united previous to the immersion of the cloth, and the fibres will still unite themselves with the compound, but not so equally and permanently as when dipped into each of the solutions separately. But the sulphuric acid has rather too strong an affinity for the clay to yield it readily even to wool. Most dyers, therefore, add to the solution of alum a quantity of tartar. Tartar is composed of potash and an acid found in grapes and some other vegetables, called tartaric acid.

When solutions of alum and tartar are mixed, the sulphuric acid quits the clay and seizes on the potash, dislodging at the same time the tartaric acid, which seizes in turn on the clay just abandoned by the sulphuric acid. The tartaric acid, having a weaker affinity for the clay than the sulphuric acid possesses, yields it more readily to the cloth. Another purpose is also gained: he sulphuric acid remains combined with he potash, and this corrosive substance is hereby prevented from injuring the texture of the cloth. For cotton and linen, which have a weaker affinity to clay than wool or silk, another process becomes necessary. Lead or lime dissolved in acetic acid (vinegar) is poured into the solution of alum. A solution of sugar of lead is frequently used. The sulphuric acid quits the clay and seizes on the lead or lime, both of which, united with this acid, form insoluble powders, which fall to the bottom, and the acetic acid unites with the clay, for which it possesses only a weak affinity, and readily yields it to the cotton or linen immersed in it.

Metallic salts may also be used as mordants. Those of iron and tin are extensively used in dyeing. Iron is used as a mordant in two states, in that of sulphate of iron, (copperas,) or acetate of iron, that is, iron dissolved in vinegar or in the acid obtained by distilling wood (pyrolygneous acid.)

Tin is used as a mordant in three states—dissolved in nitro-muriatic acid, (a mixture of the acids obtained from saltpetre and from common salt,) in acetous acid, and in a mixture of sulphuric and muriatic acids. The nitro-muriate of tin is the common mordant employed by dyers. It is prepared in the following manner: Melt block tin and pour it into water briskly agitated with a bundle of small rods, take of this granulated tin 2 oz., nitric acid 1 lb., water ½ lb., common salt or sal ammoniac 2 oz., mix them together in a glass vessel, and the tin will be slowly dissolved.* When nitro-muriate of tin is to be used as a mordant, it is dissolved in a large quantity of water, and the cloth is dipped in the solution until sufficiently saturated. It is then taken out, washed, and dried. Tartar is usually dissolved in the water along with the nitro-muriate of tin. This changes the compound into a solution of the tartrate of tin and nitro-muriate of potash. The tartrate of tin is again decomposed by the cloth. The metal quits the acid and attaches itself to the fibres of the cloth, and in this state possesses a strong affinity for coloring matters, and forms with them the most permanent and brilliant dyes.

Tan is also employed, along with other mordants. It is found in nutgalls, oak and hemlock barks, sumach, and in a great variety of other vegetables. It is that part of barks, &c. which has a strong affinity for glue, of which hides are chiefly composed, unites with it and forms leather. It has a strong affinity also for cloth and for several coloring matters. Silk is capable of absorbing a very great proportion of tan, and thereby acquires a great increase of weight. For this purpose alone it is sometimes employed by silk manufactures. Tan is often employed, also, along with other mordants, in order to produce a compound mordant. Oil is also used for the same purpose, in dyeing cotton and linen.

Besides these mordants there are several other substances frequently used as auxiliaries, either to facilitate the combination of the mordant with the cloth, or to alter the shade of color; the chief of these are tartar, sugar of lead, common salt, sal ammoniac, sulphate of copper, (blue vitriol,) acetate of copper, &c.

Mordants not only render the dye permanent, but have also considerable influence on the color produced. The same coloring matter produces very different dyes, according as the mordant is changed. Cochineal, with salts of iron, produces black,—with salts of tin, scarlet,—and with alum, crimson. In dyeing, then, it is not only necessary to procure a mordant which has a sufficiently strong affinity for the coloring matter and the cloth, and a coloring matter which possesses the wished-for color in perfection, but we must procure a mordant and a coloring matter which, when combined together, shall produce the wished for color in perfection.

The colors denominated by dyers simple, because they are the foundation of all their other processes, are four, viz. blue, yellow, red, and black. A few simple directions for dyeing wool, silk, and cotton, of these colors, will now be given. We write for prudent and economical housewives, silk culturists, and agricultural manufacturers, and the means within the reach of such must therefore be kept continually in view, in all the operations recommended.

Blue.—Indigo is the only substance that can be economically used in families for coloring blue. The best or purest indigo is

* When common salt, which is composed of muriatic acid and soda, or sal ammoniac, composed of the same acid and ammonia, is mixed with diluted nitric acid, a part of the nitric acid seizes on the soda or ammonia, and sets at liberty a part of the muriatic acid, which mixing with the remaining nitric acid, forms nitro-muriatic acid, (aqua regia,) which readily dissolves tin, gold, &c. It is more economical, however, to add sulphuric acid enough to saturate the base of the salt, which sets all the muriatic acid at liberty, and leaves the nitric acid undiminished.

light, easily powdered, tasteless, almost destitute of smell, and breaks smoothly, that is, with smooth surfaces. Some will float on water, and this is generally the purest. The color of indigo also varies. There is the blue, the violet, and copper colored. Although these may all contain nearly the same quantity of coloring matter, yet they are differently valued, the blue selling 20 per cent. higher than the violet, and from 40 to 80 per cent. more than the copper colored. The blue is preferred by dyers for combination, or solution in sulphuric acid, and the copper colored for the indigo vat, in which it is dissolved in a potash ley, aided by bran, madder, or other vegetable products, in a state of fermentation. Before indigo can be applied and fixed upon the fibre of cloth, it must be dissolved in water. But it cannot be dissolved in water in its blue state; it must be converted to a green or yellow color, and then it readily dissolves, is attracted by the fibres of the cloth, becomes permanently combined with them, and on being exposed to the air becomes again blue. In the solution of the indigo, therefore, consists the whole art of coloring blue. The following are among the most easy and simple methods of dissolving indigo, or, in other words, forming a blue dye.

First Method.— Take indigo, well powdered, one ounce; quick lime, one ounce; potash, two ounces; copperas, two ounces; molasses, half a pint; warm water, one gallon. Mix, and stir occasionally, keeping the vessel, of copper, iron, or earthen, well covered and in a warm place. The liquor will soon become green, covered with a copper colored or blue scum. In twenty-four hours it will be fit for use. Immerse the stuff to be colored for a longer or shorter time, according to the shade required. The strength of the color may also be varied by using a greater or less quantity of water. A very little practice will enable any one to give wool, silk, or cotton, properly prepared, with this dye, a beautiful and permanent blue, of any shade they may choose.

Second Method — *Saxon Blue.*—In this method, the indigo is dissolved by the aid of sulphuric acid, without losing its blue color, but it undergoes a change which renders it less permanent, and is therefore not much used, except for articles not very durable, or when a deep, unfading tint is not considered of much importance. This preparation is kept in the shops, under the name of *Liquid Blue*, or *Chemical Blue*, and is much used for blueing white cotton and linen garments, from which it is readily washed out, even in cold water. It is also extensively used in coloring greens, giving, with yellow, a more brilliant color than the blue obtained by the first method. On wool and silk it is much more durable than on cotton, and on articles which do not require frequent washing, may be often used advantageously as a blue dye. It is prepared as follows:

Take indigo, well powdered, one ounce; sulphuric acid, four ounces. Mix it in a glass or stone ware vessel, and let it stand twenty-four hours, stirring it occasionally—then add one ounce of dried potash. Let it stand twenty-four hours longer, add half a pint of water, and bottle it up for use.

Mix a wine glass full of this liquid in a pail full of boiling water, and dip the stuffs till they acquire the color desired. More of the liquid must be added when the water becomes nearly clear, before the stuffs have acquired a color sufficiently deep.

Yellow.—There are a great number of imported and native plants, roots and barks, that, by the aid of the mordants alum and tin, dye yellow. But the very best of all these, viz. the yellow oak bark, or quercitron bark, as it has been named in England, being very plenty in this country, it seems altogether unnecessary even to mention any other.

To dye 10 lbs. weight of cloth, or woollen stuffs, of the highest and most beautiful orange yellow, 1 lb. of quercitron bark, and the same weight of murio-sulphate of tin, will be required*; the bark, powdered and tied up in a bag of thin cotton or linen cloth, may be first put into the dyeing vessel, which of course must be brass, copper, glass or earthen, with hot water, for the space of six or eight minutes; then the murio-sulphate of tin may be added, and the mixture well stirred two or three minutes. The cloth, previously wet thoroughly with warm water, may be put in and turned briskly a few minutes; the color applies itself in this way so equally to the cloth, and so quickly, that after the liquor begins to boil, the highest yellow may be produced in less than fifteen minutes, without any danger of its proving uneven.†

---

* Murio-sulphate of tin. This preparation differs somewhat from the muriate of tin, or nitro-muriate of tin, the method of preparing which is given in a preceding part of this essay. It is prepared as follows: Take six ounces of muriatic acid, and pour it upon about the same weight of tin, granulated as above directed, in a glass vessel. Then pour slowly upon the same four ounces of sulphuric acid, and let it stand in a warm place till the acids saturate themselves with tin, that is, till they will dissolve no more, which will be soon effected, if heat be applied, and gradually without being heated.

† Should a deeper orange tint be desirable, add to the quercitron bark a little madder, perhaps an ounce or less to the pound of bark, according to the color desired. This will greatly increase the beauty of the color, when examined by candle-light.

When a bright golden yellow, approaching less to the orange, is wanted, four ounces of the murio-sulphate of tin, and two ounces of alum, and one pound of bark, managed in the same manner as above directed. Pure bright yellows, of less body, may be colored by employing smaller portions of the articles above mentioned.

A good yellow may also be produced by boiling the cloth for one hour in one seventh of its weight of alum dissolved in a suitable quantity of water, and then, without being rinsed, put it into a dyeing vessel with clean hot water, and about as much quercitron bark, tied up in a bag, as was used of alum. Boil and turn it as usual, until it takes sufficient color, then dip it in warm lime water for ten minutes, and rinse it well immediately afterwards. Tin, however dissolved, when used in coloring wool or silk, renders the fibres a little harsh; but this may be in a great measure obviated by employing the murio-sulphate of tin with a mixture of alum, or alum and tartar, and combining these with the coloring particles of the bark before they are applied to the stuffs.

In dyeing silks, more alum and less tin should be used than is directed for woollens, because tin, unless used sparingly, always diminishes the glossiness of the silk.

To produce a lively yellow on silks, it will be sufficient to boil after the rate of four ounces of bark, three ounces of alum, and two ounces of the murio-sulphate of tin, with a suitable quantity of water, for ten or fifteen minutes, and the heat of the liquor being reduced so that the hand can bear it, the silk is to be put in and dyed, as usual, taking care to agitate the liquor continually, that the coloring matter may not subside until it has acquired the proper shade. By adding very small proportions of *cochineal* to the bark, the color may be raised to a beautiful orange, or even aurora. A similar effect, though less brilliant and beautiful, is produced by adding madder to the quercitron.

A Yellow on Cotton and Linen. — It has been said that the fibres of cotton and linen have not so strong an affinity for clay and tin as those of wool and silk. A somewhat different management, therefore, becomes necessary in coloring the former goods, from that which is required for the latter. The fibres of linen or cotton are prepared for dyeing by being first boiled in water, with a portion of potash, and afterwards bleached. It should then be soaked in water soured with sulphuric acid, to dissolve and remove all earthy matter, and be then thoroughly rinsed, to free it from the acid. Alum, and not tin, must be used as the mordant, for although tin gives yellows exceeding all others in lustre and beauty, on cotton, they decay very speedily when exposed to the sun and air.

For 1 lb. of cotton and linen yarn, or cloth, take alum 3 ounces, sugar of lead 1 ounce—dissolve them in one gallon of water, about blood warm, and soak the stuff two hours; take it out, moderately squeeze or wring it, let it then be dried, and then soaked again in the solution of alum, squeezed and dried as before; then let it be thoroughly washed in lime water and dried as before. Let it then be well rinsed and put into a kettle of cold water with three ounces of quercitron bark tied up in a bag; stirring it frequently, gradually raise the water to a boiling heat; let it boil a few minutes only, as longer boiling would injure the color, and take it out, rinse and dry as usual. It has been found that by immersing cotton a great number of times, alternaely itn the solution of alum and lime water, and drying after each immersion, the color acquires greater body and durability. The reason of this seems to be found in the shrinking of the aluminous basis (the clay) in drying, and thereby making room for an additional quantity to penetrate the fibre after each drying; and the larger the quantity of this substance united or incorporated with the cotton, the deeper and more durable will be the color fixed upon it.

There are other methods of preparing cotton, so that it will take a sufficient quantity of the clay, from alum, without the use of the sugar of lead, and which are, consequently, somewhat cheaper than the one described above.

Take of the roots of our common sumach, (rhus glabrum,) dried and chipped, one pound, sal soda four ounces, or barilla half a pound, which is an impure soda used by manufacturers of hard soap, and in two or three gallons of soft water boil them for one hour, and then strain off the liquor and steep the cotton therein for two or three hours. Take it out of this liquor, and steep it for the same length of time in a mixture of warm water and fresh cow dung; rinse it out and dry it. Dissolve three ounces of alum in one gallon of water, soak the cotton in this and lime water alternately, and dye it slowly with the quercitron bark as before directed. By the addition of madder, the yellow may be raised to orange, &c.

Woollen, silk, or cotton goods, colored yellow as directed, may be immersed in the saxon blue dye, (second method,) and made to take any shade of green which may be desired.

Red. Crimson, on Wool or Silk.—Provide yourself with the following articles:

alum ½ lb., cream of tartar ¼ lb., Nicaragua wood 1½ lbs. Dissolve the alum and tartar in four pails of water, in a brass or copper kettle; when boiling, put in the cloth, yarn, &c., and continue the boiling two hours, then take it out and cool and wash it. Fill the kettle again with water, put in the Nicaragua wood tied up in a bag, put in the cloth and boil one hour, take it out and wash it, and if you wish to change the color to crimson, add one ounce or more of pearlash to the liquor, and boil again for fifteen minutes.

Madder Red.—Soak the cloth, &c. as directed in the last receipt, then, instead of the Nicaragua wood, put into four pails full of water, 1¼ lbs. of madder and ¼ lb. of the nitro-muriate of tin, and when blood warm put in the cloth and turn it continually till it boils, take it out immediately and dip it into lime water, and turn it for a few minutes without boiling, take it out and wash it, &c. The quantity of dye-stuffs mentioned in these receipts are calculated for about 2½ lbs. of woollen goods.

Scarlet.—Firstly, color as directed for the most brilliant yellow, then take one ounce of powdered cochineal for every pound of cloth, and put it into the yellow dye from which the cloth has been just taken, or into a suitable quantity of clean water, with one ounce of murio-sulphate of tin. Put in the cloth, and boil it for fifteen or twenty minutes, wash and dry as usual.

To color cotton red, with Brazil or red-wood, Nicaragua wood or madder, it must be soaked in alum water, and otherwise managed as directed for yellow, the red wood, &c. being used instead of the quercitron bark.

(*To be continued.*)

New Machine for cleaning Hemp.—It has long been a great desideratum in the manufactures of this country to discover the means of extracting the glutinous matter from hemp, and to reduce this article to a *fine fibre*, suitable to the same purposes as flax. This useful object has been generally supposed attainable, though many unsuccessful experiments had been made; but we are happy to announce, that it has at last been accomplished. Mr. Alexander Shanks, junior, flax-spinner, Arbroath, an ingenious mechanic, after considerable application, has invented a machine, composed of two metal plates of a peculiar construction, supported by springs to modulate the compressure; and the hemp in passing through these plates undergoes a friction from the action of the plates, and after passing through several rollers, it leaves the machine free of the glutinous matter, and of a soft delicate fibre. When thus prepared, and heckled, it is equal to the finest flax, and may be spun and applied to the same purposes as the last mentioned commodity. The expense attending the process of preparation is very trifling, the machine being moved by steam power (which may be borrowed from any work where there is a steam engine), and a boy may attend and feed the machine in its operations. The quantity of prepared hemp produced will of course depend upon the size of the machine. It may be mentioned, that the machine is so contrived that the friction does not cut or injure the fibre, but simply removes the glutinous matter adhering to the hemp in its original state, and reduces it to a fine soft fibre. When we consider that the price of hemp is only about half that of flax, and that the prepared hemp is equal, and for some purposes superior, to flax, the great usefulness of this invention must be manifest. We understand Mr. Shanks has secured the benefit of his useful discovery by patent, and from all that we have learned, it will be of great public advantage.

We understand that Mr. Daniel Duff, of this place, introduced a similar mode of preparing hemp, which has been practised here for a considerable time, and has been found to answer the purpose very well. We are not aware of what may be the additional advantages attending Mr. Shanks' plan, that have entitled him to take out a patent for what he deems a discovery.

After we had written the above, a gentleman called at this office with a sample of prepared hemp; which, he assures us, is superior to that prepared either by Mr. Duff or Shanks. It is manufactured by Mr. J. G. Norrie, who has bestowed no little time and trouble on the invention of his apparatus, and the article is pronounced, by judges, equal in appearance to the finest flax. This discovery has created considerable interest among the merchants and manufacturers in our town and neighborhood for some time past; and many persons have been making experiments to attain the desired object. Candor, however, compels us to state, that many of our manufacturers are of opinion, that hemp prepared in this manner loses in strength what it appears to have gained in apparent fineness of fibre.—[Dundee Courier.]

Suspension Bridges.—At a meeting of the Clinton Suspension Bridge Committee last week, Mr. West's report on the principle of wire suspension bridges was read and approved. This gentleman has recently been examining the suspension bridges of France and Switzerland, most

of which are of wire. He stated that previously to the opening of the Fribourg bridge, in October last, proof was made of its capability of sustaining great weight, by placing 36 horses, 14 pieces of artillery, and 300 people upon it at one time, which did not cause the slightest derangement in the structure. Upon the occasion of opening the bridge, a grand procession of the clergy and municipal authorities took place, when no less than 1,800 persons, estimated at 90 tons, were at once on the bridge. The two largest bridges over the Soane, at Lyons, are of wire, and are crossed by the heavy French diligences, weighing 5,000 lbs. each, and allowed by law to carry 6,000 more.—[English paper.]

[From the Journal of the Franklin Institute.]

Notice of the Sandy and Beaver and the Mahoning Canal.

Two companies have been chartered by the Legislatures of Ohio and Pennsylvania, to construct canals to connect the western termination of Pennsylvania with the Ohio and Erie canal. A charter for the Mahoning, or northern route, was first obtained; subsequently, a charter for the southern, or Sandy and Beaver route, was granted.

The Sandy and Beaver route commences at the mouth of the Big Beaver, twenty-eight miles below Pittsburg, and continues down the north flats of the Ohio river, to Little Beaver creek; thence it occupies the valley of that stream, till it reaches the town of New-Lisbon, a short distance north of which it ascends, by a narrow ravine, to the dividing ridge between the waters of the Beaver and Sandy; after crossing which, it continues along the valley of the Sandy, and gradually descends to its mouth, near which it intersects with the Ohio and Erie canal, at Bolivar.

The route is ninety miles in extent, and is located through an extremely rich and fertile country; the summit occupies the dividing ridge between New-Lisbon and a point west of the town of Hanover, a distance of fourteen miles; it receives the drainage of eighty square miles of country, and is to be supplied with water from Cold Run, Brush Run, and west fork of Little Beaver creek, Sandy creek, Holland's creek, Mendenhall's run, and Davis' branch; in addition to which, the head waters of the Mahoning can be conducted into it by means of a short feeder. These streams, at their minimum, afford sufficient water for the transit of seventeen boats per day, and, during nine months of the year, an average flow of 2,570 cubic feet of water per minute: an amount adequate to accommodate a trade of 295 boats per day; in addition to this, it is proposed to erect reservoirs, from time to time, as the business may require. Many eligible sites for this purpose are to be found contiguous to the line, four of which have been surveyed, and found to have capacity to contain 280,000,000 cubic feet of water, and would inundate 726 acres of land.

The work is to be constructed of the same dimensions as the Pennsylvania and Ohio canals; the locks, aqueducts, and bridge abutments, are to be formed of sand-stone, and are intended to be of the most permanent character; the country through which the route is located affords materials for the construction of the work, such as stone, timber, and hydraulic lime, of the best description, and in the greatest abundance; the cost of the whole work, including reservoirs, is estimated at $1,289,000.

The Governor of Ohio, in his last annual message, mentions the Sandy and Beaver canal in the following favorable manner: "Viewing a communication between the Pennsylvania and Ohio canals to be a subject of great interest, it is with peculiar satisfaction I communicate to you the intelligence, that the Sandy and Beaver canal company was organized during the last summer, under the liberal provision of the original charter, and the munificent grant of the legislature, in an amendatory act of the last session." "By the report of two able and experienced engineers, all doubts have been removed from the public mind, as to the supply of water on the summit, and is conclusive as to the question of an abundant supply of water for all the demands of an extensive commerce." "Such a connexion has long been a desideratum to the people of the interior and southern parts of Ohio, as it will open to them a new and short route to the eastern markets for their abundant produce, and will enable eastern and western merchants to transport goods from the east at a much earlier period of the spring than by the New-York canal."

The Mahoning, or northern route, commences at the village of Akron, on the Ohio and Erie canal, and from thence extends, in an easterly direction, to the Little Cuyahoga, at Middlebury; "from which it pursues a north-easterly course, until it approaches near the main Cuyahoga, in the township of Stow; thence continuing the same general direction along the south and south-east bank of that river, until it passes the village of Franklin, it enters the valley of the Breakneck creek, and passing up that valley in an easterly course, it crosses the summit between the waters of the Cuyahoga and Mahoning branch of the Big Beaver, near the village of Ravenna. The line then descends rapidly into the valley of the west branch of the Mahoning, crosses that

stream near its south-westerly bend, continues along its north bank, recrossing that branch, and also the south, or main branch, a mile above the junction of those streams; then leaving the river, the line pursues an easterly course, again approaching the river opposite the village of Warren," and then continues along the valley of the river, in a south-easterly direction, to the Big Beaver; thence it follows the valley of the Big Beaver, and connects with the Ohio at the town of Beaver. The whole distance from Akron to the Ohio, by this route, is about one hundred and twelve miles.

The canal commissioners of the state of Ohio, in their report on this route, propose to supply the summit level with water by the following means.

1st. By a feeder from Breakneck creek. This stream, they state, may be introduced by a feeder three miles and six chains in length, and is sufficient for the supply of the summit level, and the contiguous levels, in ordinary seasons, during more than half the year. In the dryest seasons, when the flow of water is reduced to the least quantity, it yields about 240 cubic feet per minute.

2d. By forming reservoirs of four lakes, or ponds, situated near the summit. These bodies of water, Muddy Pond, Sandy Pond, Brady's Lake, and Lake Pippin, may, they state, be converted into valuable and convenient reservoirs, for the supply of the summit, and the adjacent levels; the two former will contain an area of about 240 acres. Water to the depth of twenty feet, or even more, may be accumulated in these ponds, and conducted into the canal, by means of a feeder, seventy-eight chains in length. A depth of eight or ten feet of water on the area of Brady's Lake, and Lake Pippin, may be made available to supply the canal in dry seasons.

It is computed that 325,000,000 cubic feet of water may be reserved for use in these reservoirs.

It will be perceived by the foregoing description—deduced from the reports of Maj. Douglass, Col. Kearney, E. H. Gill, H. Hage, and Col. Dodge, the engineers that examined the routes—that the summit of each canal has to rely on reservoirs, during a period of drought, for a supply of water. By an examination of their respective charters, it will be found that the stockholders of the northern, or Mahoning route, are permitted to receive but ten per cent. on the cost of the work in tolls, while the Sandy and Beaver canal company are allowed twenty; in addition to which, it has received from the Legislature of Ohio the following very liberal grant, which alone, in a very few years, will much more than repay the cost of the work.

"That when the canal authorised to be constructed by the act, entitled an act to incorporate the Sandy and Beaver Canal Company, shall have been completed twenty miles from the Ohio canal, said company shall be entitled to collect and receive the tolls accruing on the Ohio canal, on all freight and passengers that may be transported thereon, and which have been transported not less than twenty miles on said Sandy and Beaver canal, to the Ohio canal; and to receive the toll on all freight and passengers that may be transported thereon, and discharged and landed in said Sandy and Beaver canal, at any point not less than twenty miles from the Ohio canal, for the term of seven years from and after the completion of the twenty miles of canal aforesaid."

Viewing the two routes in point of accommodation to the trade of the west and south-west, embracing the states of Kentucky, Indiana, Illinois, Missouri, and the most fertile portion of Ohio, it will be observed that, by the Sandy and Beaver route, the distance to Pittsburg, or Philadelphia, is sixty-five miles less than by the Mahoning, or northern route.

The western termination of the Sandy and Beaver canal is in 40° 36′, north latitude; Pittsburg, 40° 28′; and Philadelphia, in 39° 57′. Hence, it will be perceived that the three places are nearly in a direct line. These facts portray, in the strongest light, the merits and advantages possessed by this route over any other, and that it is the most direct and desirable continuation of the Pennsylvania canal. From the western termination of the Sandy and Beaver canal, at Bolivar, the distance by the Ohio canal, Lake Erie, the New-York canal, and Hudson river, to the city of New-York, is 780 miles; and by the Sandy and Beaver route, and Pennsylvania improvements, to Philadelphia, 511: making a difference between these two communications to the sea-board, of 269 miles. In addition to this very decided advantage in distance in favor of the Pennsylvania and Ohio communication, is to be added safety, economy, and despatch, and the long periods in spring and autumn which it could be used, when the lake route would be obstructed by ice, or hazardous, as is often the case, by storms.

The immense commerce that the Sandy and Beaver connection will secure to our market cannot at present be approached, even by conjecture. If we view the vast extent of rapidly improving country, where cities and towns are springing up as if by magic, two-thirds of the rich products of which must seek our market through this channel, some distant idea may be formed of the benefits our present chain of internal

improvements, and the city of Philadelphia, are destined to derive from this communication.

As both the northern and southern route have to receive a supply of water, during a dry period, from reservoirs, the following statement may prove interesting.

Letter of E. H. Gill, Esq., Civil Engineer.

Philadelphia, Dec. 29, 1834.

SIR: In conformity with your request, I hand you the following statement, descriptive of the merits of the summit of the Sandy and Beaver canal, compared with the Licking summit of the Ohio canal; the latter, you will perceive from the annexed letter from the present acting canal commissioner of the state of Ohio, Leander Ransom, Esq.,—the general accuracy of which I can vouch for, from my own personal observation,—has thus far been, in a measure, entirely supplied with water by a reservoir; this reservoir covers an extent of about 2,400 acres, and, when full, has a depth of six feet above the plane of the water in the canal, and is said to contain 570,000,000 cubic feet of water; it is located on a stream which, during ordinary seasons, affords a flow of fifty cubic feet per minute, but which, during the latter part of the last summer, was entirely dry. The reservoir receives the drainage of from thirty to forty square miles of country, and, during all portions of the year, it alone has to supply near thirty miles of the summit, and dependent levels, with water, and, during the dry season, about forty-four miles. At the period of my visit to the reservoir, which was during the dryest part of the past season, there was a flow from it into the canal of 1,329 cubic feet per minute, which, at that time, was the only supply received by the summit, and its then dependent levels. The average number of boats then passing was eight per day; to convey which across the summit required at least an expense of twelve locks full of water per day, equal to 112 cubic feet per minute; if to this sum is added one hundred cubic feet per minute, for leakage at the locks, (which were in a very bad condition,) there will be left for evaporation and filtration on the forty-four miles supplied from the reservoir, 1,117 cubic feet per minute, or 25 cubic feet per mile.

This, though I shall, in the following calculations, assume it as datum, is by far too liberal an allowance, because, from measurements and observation, made by me at the time, I found that the upper level, which is nine miles in extent, and through ground of a similar character, to the summit of the Sandy and Beaver canal, but 117 feet per minute were lost by evaporation and filtration, or 13 c. feet per mile per minute.

The minimum natural flow of water into the summit of the Sandy and Beaver canal, during the dryest period of the year, and measured during the past extremely dry season, is 558 cubic feet per minute, (though for nine months of the year it will average 2,570 cubic feet per minute;) the extent of line dependent on this supply is twenty miles, but seven of which, from the peculiarly favorable formation of the soil, and its wet and springy nature, can possibly require any allowance for leakage and evaporation. If, on this seven miles, an allowance for leakage and evaporation of twenty-five cubic feet per mile per minute is made, amounting in the aggregate to 175 feet per minute, there will still be left 383 cubic feet per minute for leakage at the locks, and the purposes of navigation; sufficient to accommodate a trade of thirty-eight boats per day, (the locks having a lift of six feet,) during the dry season, without any aid whatever from reservoirs.

No section of country is, perhaps, more favorably formed, in point of soil and topography, for the construction of numerous and large reservoirs, than that through which the summit of your proposed work is located; during my recent examinations there, sites for four were examined, having capacity to contain 280,649,600 cubic feet of water, and would receive, from actual survey, the drainage of forty-eight square miles of country. Assuming that seventy per cent. of the annual rain that falls, can be collected into reservoirs, which admits of no doubt, being within the limits of the result of actual experiment, and that thirty-six inches in depth of rain falls annually in your latitude, and the above described section of country will afford the reservoirs a supply of 2,810,141,720 cubic feet per annum; in addition to which, the summit drains fifty-two square miles of country, fifty per cent. of which could, if required, be laid up in other reservoirs, making, in the aggregate, 4,985,164,800 cubic feet of water, upon which no demand need be made but in the dry season, or ninety days in the year.

In drawing a comparison between the Licking summit of the Ohio canal, and that of your proposed canal, it will be observed the former has an extent of forty-four miles, which is entirely dependent on the reservoir for water during the dry season; that the natural flow of water into that reservoir is but fifty cubic feet per minute, the drainage about thirty-five square miles, and the maximum depth of the reservoir is but six feet; while the latter has an extent of but twenty miles, to meet the demands of which there is a natural flow, at the driest periods of the year, of

550 cubic feet per minute; in addition to which, numerous reservoirs may be formed as required, varying from ten to thirty feet in depth, and having a surface of eighty square miles, to supply them with water.

The very favorable result afforded by the Licking reservoir may be fully anticipated from the proposed works of a similar character on the summit of the Sandy and Beaver canal; the soil and country are alike, and their proximity to each other renders each alike subject to the effect of the same changes of climate. I cannot think any other evidence than a comparison requisite to satisfy an unbiassed mind, that the supply of water that can be obtained on your proposed canal route is far more than adequate to meet the demands that may be made on it.

But other evidence, if requisite, can be adduced in favor of the firm reliance that can be placed in reservoirs; if we look to France, there we find the Languedoc canal supplied in a great measure from a reservoir; if we refer to England, we find the Rochdale, the Huddersfield, the Nottingham, the Oakham, the Oxford, the Dudley, the Stourbridge, and the Grand Trunk canals, the summits of most of which are entirely supplied with water by reservoirs. In Scotland, they have been found of immense advantage. In our own country, we have, in addition to the Licking and Portage summits of the Ohio canal, which are supplied by reservoirs, the summit of the Chesapeake and Delaware canal, which is, of itself, a large reservoir, and receives but a small portion of constant running water, and the summit of the Union canal. The Schuylkill Navigation Company has, during the late dry season, received great assistance from the reservoir lately erected at the head of their works.

Very respectfully, yours,

E. H. Gill, Civil Engineer.

B. W. Bakewell, Esq.,
One of the Directors of the
Sandy and Beaver Canal.

Extract from a letter from Leander Ransom, Esq., Acting Ohio Canal Commissioner, in relation to the Licking Summit and Reservoir.

"The extent of country drained by the reservoir is between thirty and forty square miles.

"The extent of line supplied in part to the westward of the reservoir is about thirty miles in the driest part of the season; however, the water received from other sources is very inconsiderable, much depending on the duration of the drought. In the driest part of the season, nearly thirty miles to the westward, and fourteen north-east, in all forty-four miles, are supplied from the reservoir.

"The reservoir is supposed to contain, when filled to six feet above top water line of the canal, about 870,000,000 cubic feet of water, about 570,000,000 of which is available, and to cover about 2,400 acres.

"Something of an idea of the expenditure of water from the reservoir for a part of this season, may be formed from the following observations, to wit: On the 25th of June, the water in the reservoir was 4 feet 5 inches above top water line in the canal; July 13th, 4.9 feet; August 27th, 3.9 feet; September 24th, 3 feet. No rain having fallen from July 4th to September 24th."

Mr. Ransom states that the reservoir could have been filled much more, but it was not considered necessary; and the superintendent informed me that it could have been filled in July, had it been deemed requisite. E. H. G.

School of Civil Engineers.—The trustees of Rensselaer Institute met on the 22d May, to receive the statute passed the 9th May, empowering them to organise a school of civil engineers as a branch of the Institute. Regular degrees of Civil Engineer are to be conferred by the President, Rev. Doct. Nott, in October annually, on those who are qualified theoretically and practically, and over 18 years of age. This is the first school of the kind ever organized on this continent. The Royal Military Academy at Woolwich, England, and the Polytechnia, in Paris, have branches nearly similar. Professor Eaton takes the immediate charge of this department; Adj. Prof. Hall having been appointed to take the chief charge of the Natural Sciences. A very spirited corps of 6 or 8 young gentlemen have already entered the division, and will probably offer themselves for the degree of Civil Engineer in October. Two afternoons in each week will be devoted to the application of elementary principles to works in this vicinity, such as railroads, canals, bridges, water-works, mill-works, factories, &c. &c.

The Board of Trustees now consists of the eight appointed members from Albany, Troy, Lansingburgh and Waterford, (two from each,) with the addition made by the late statute of the Mayor, Recorder, and one Alderman, of this city. The list of officers stands thus: Rev. E. Nott, D. D., President; Judge David Buel, Vice President; Hon. George Tibbitts, Hon. J. P. Cushman, William D. Haight, Esq., *ex-officio*; Hon. Jesse Buel, and Philip Van Rensselaer, Esq. of Albany, Hon. J. D. Dickinson, and R. P. Hart, of Troy, are the Prudential Commit-

tee; Elias Parmelee, Esq. and Rev. Phineas L. Whipple, of Lansingburgh, Gen. Guert Van Schoonhoven, and the Hon. John Cramer, of Waterford, constitute the Board of Trustees; Amos Eaton, Senior Professor and Agent, also Acting Professor of Civil Engineering; Ebenezer Emmons, of Williams College, Junior Professor; James Hall, Adjunct to the Junior Professor, and performing the duties of that office. Special Assistants are appointed temporarily. Dr. Moses Hale, Secretary, and H. N. Lockwood, Esq. Treasurer.

The degree of Bachelor of Arts, heretofore conferred on the general graduate, is changed to *Bachelor of Natural Science*. We consider this a good change, as the name is now more appropriate. The degree of Master of Arts is still retained as an honorary diploma for the general graduate, as well as the engineer, after three years of successful improvement in the useful application of his talent. E.—[Troy Daily Whig.]

Modern Fortification.—[In the following article, the reader will discover that the writer has made himself thoroughly acquainted with the subject. Being a practical engineer, in the government service, and in the constant practice of applying those principles which must necessarily make him familiar with the science to which he is devoted, no other recommendation would be required, than the perusal of the essay, to convince any one of the qualifications he possesses over the ordinary class of collaborators upon this particular department of knowledge. While we express our indebtedness to the same talented gentleman for contributions he has in times past made to this publication, we cannot refrain from indulging a hope that he will hereafter embody, in a distinct volume, an elementary work on engineering, so much needed in our country, whose resources will be developed in proportion to the skill, science, and thorough investigations of those who make it their business to defend man against the incursion of his fellow man; —stay the billows of a restless sea, by the construction of walls, and trace out those courses through the hills and the dales, by which intercourse with distant provinces may be accelerated, and convenience and human happiness increased.]

The science of war has always been of deep interest to mankind, and will doubtless continue to be so for ages yet to come. Although war is one of the greatest misfortunes that can befal a nation, whether through its own fault or that of another, still it is one of the evils for which we must be prepared, even as we would prepare to defend ourselves against personal violence, in travelling through a land where no laws could protect us. For though the common consent of men of various countries has sanctioned a code of principles known as the Laws of Nations, these cannot always avail where there is no adequate power to enforce them. Nations as well as individuals may do wrong; but where is the authority to arrest them, or where the court to give sentence? They may be the aggressors, and enter innocent lands with fire and sword, ravaging and plundering; but who will shield the injured party, if it make no effort in its own defence? The hand of Omnipotence, will it be said? No: the deity works by means, and neither nations nor individuals are so innocent in his sight as to be free from the calamities of life, or exonerated from making any effort to avoid them. Would the advocates of unconditional peace consent to abolish all law in the land, and let the robber and murderer go free? Or, in such a state of things, would he offer no resistance to a personal attack, when there was no law to redress him? Yet such must be his conduct, to be consistent with his principles. Doubtless it is our duty to avoid war as much as in our power, by giving no just cause for complaint on the part of other nations. The great apostle of our Savior says, "If it be possible, as much as in you lieth, be at peace with all men." But this doctrine is evidently different from that of unconditional submission, inasmuch as it implies that there are cases where it is not in our power to be thus at peace, unless by bowing our necks to oppressors, who would cry "peace, peace," when "there is no peace." While, therefore, we rejoice that the more enlightened, just, and humane policy of nations is removing many of the causes of war, we still think it necessary to be always prepared to resist aggression, as the surest way to prevent its being attempted. How far we ought to suffer wrong, before taking arms in offensive war—how great should be the

provocation to justify the first step—is a question which requires the united wisdom of a nation to decide. But to deal so justly and honorably with other nations, that they shall have no *cause* for war, and to present a front so united and defended that they shall not wish to *seek a cause*—this is *our* principle of universal peace, and one which, if universally followed, could not fail to accomplish its object.

These remarks are preliminary to a brief general description of modern Fortification, as one of the most important and effective preparations for war: we do not mean to say, the only one; regarding the construction of ships of war, the preparation of armaments for both ships and forts, the means of furnishing supplies and making communications, and the discipline of the men, as all of equal importance to a successful war. But as the construction of vessels and fortifications requires the longest time among these preparations, so should they be the earliest commenced, and most regularly prosecuted to their completion. It is the present policy of our government, as it long has been, to establish a system of fortifications on our seaboard, especially for the defence of our most important cities and harbors. We deem this a wise and prudent policy, worthy of a great and enlightened nation. We regard the moneys thus expended for national defence, in the light of a premium of insurance to the lives and property thereby protected. The merchant who insures his vessel does not intend that it shall therefore be lost at sea, nor does the citizen, insuring his house, expect thereby to cause its destruction; neither does the building of forts imply a wish to engage in war, or an intention to do so. Far from being the means of bringing on a war, this is the very way to avoid it, by diminishing the chances of success to an enemy.

A fort is a strong enclosure to protect a weaker body of men within it against a stronger body without. Forts are often constructed for the defence of harbors, by firing against the ships of an enemy. If the enemy would always remain on board his ships, a simple water battery would answer every purpose. But as it is presumed that the foe would attempt to land with a stronger force, and take possession of the battery, it becomes necessary to protect the latter by walls in rear, and on each side; so that the water battery becomes one or more of the sides of the fort, which thus forms a complete enclosure.

In a contest between a fleet and a fort, the latter has a manifest advantage, if it be not too low, or if the enemy cannot come too near it when it is low. For the men in the fort being sheltered by the walls, and firing through embrasures, or over high parapets, are very little exposed to the guns of the fleet, and only in imminent danger when the ships can so place themselves that the sharp shooters in their tops may look down upon the men in the fort, and pick them off with their small arms. For this reason, where ships can approach within 300 yards of the fort, the latter should not be less than 60 feet above water, or it would be overlooked. In all other respects the fort has a decided advantage. The men of the fort are but slightly exposed, compared with those of the vessel. The carrying away of the mast, by chain shot or balls, disables the ship, and leaves her almost at the mercy of the enemy, while her fire can seldom dismantle but a very few guns of the fort. The guns on shore admit of a steady and accurate aim, while those on the water, from the progress and rolling of the ship, are comparatively uncertain. And finally, the shot from the vessel recoils almost harmless from the walls of the fort, while the latter can fire red hot shot through the side of the vessel, or at least deep enough to be inaccessible till it can set the wood on fire without its being discovered. By firing low, if the shot strikes the water, (unless the sea is extremely rough,) it will rebound once or more, and still strike the vessel, rigging, or hull. As the guns may be fired with hot shot, and with steady aim, about twice in a minute, we may judge how effectual they must be against a vessel. The fire of the fort, with 24, 32, or 42 pounders, will begin to be effective at the distance of two or three miles; but the ship must approach within 800 yards to make any impression on the walls of the fort, and there she would soon be destroyed. So great is the disparity, therefore, between land and naval batteries, that one gun of

the former has been considered as effective as twenty of the latter. This of course supposes the former to be well constructed, and protected by an earthen parapet.

The excellence of a fort consists in its enabling a few men, shut up within it, to resist the attack of a much greater number, for a certain period of time. From the long experience of sieges, this time may be very nearly calculated for each different project, and forms one method of determining the best among several projects for the same work. For instance: a garrison of 5,000 men, in a regular fortification, should be able to hold out against a besieging army of 100,000 men for at least six weeks, supposing the siege to be regularly and closely pursued. At the end of that time, they would probably be reduced to surrender, unless succored by a relieving army; but the six weeks thus spent by the besieging army should enable an army of relief to arrive, and thus save the fort from a surrender. Some forts are much stronger than others, but none are so strong as to be absolutely impregnable, provided there be sufficient force to attack them. Gibraltar itself might be taken by building a mole or mound as high as the rock, and arming it with a battery as heavy as its own; but considering this to be impossible, Gibraltar is pronounced impregnable. Thus art assists nature in forming a strong hold; and where nature has done the least, art has to do the most. It is in level, open countries, destitute of natural defences, that the art of fortification is felt to be the most valuable.

The object of the fort is to separate the defenders, or garrison within it, from the enemy without, whose strength is thus made unavailing. This is done by means of a high wall, and usually a deep ditch, extending quite around the fort, of which they form a principal part. The ditch varies in different works from 30 to 100 feet in width, and should be too wide to admit of crossing it by ladders or portable bridges. The wall within the ditch is called the *scarp*, and is usually about 30 feet high, so that it cannot be easily scaled, if vigilantly guarded. Instead of a simple circular or polygonal form, the scarp is broken inward on each side, as represented in figure 1, which is the plan of the scarp of a regular fort, with five bastioned fronts. The projecting or salient portions are called the *bastions*, and the re-entering or retired lines connecting them are the *curtains*. The curtain with a half bastion on each side, or rather at each end of it, forms a *bastioned front*, as shown in fig. 2. The straight line, A B, is called the side of the polygon; A*b* the *left face*, *bc* the *left flank*, *cd* the *curtain*, *de* the *right flank*, and *e*B the *right face* of the bastioned front AB. Thus, a bastioned front consists of a curtain, two flanks, and two faces; which being repeated on the different sides of the polygon, form the enclosure of the fort. The object of this configuration may be thus explained: Suppose an enemy to have reached the scarp wall, and to attack the face A*b*, (fig. 1 or 2,) in attempting to enter the fort. The men who are defending this face would not be able to fire down upon the enemy at its foot; and they may be panic-struck, so as to make a weak resistance. But the men on the flank *de*, who are out of danger, can fire upon the enemy along AB with great precision; and *enfilading* them, or sweeping them in line, with grape or canister shot from carronades, would mow them down like grass before the scythe. No attack made under such disadvantage can be successful. In this manner the flank *de* will defend not only the face A*b*, but the flank *bc*, and half the curtain *cd*, or half the bastion front AB. Likewise, the flank *bc* will defend the right half of the front, from the salient B to the middle of the curtain *cd*. Thus the whole perimeter of the scarp is defended by the flanks; and the bastions become a far stronger substitute for the projecting and flanking towers of the ancient castles and walled towns.

Recurring now to fig. 2, we have a plan of the bastioned front AB more in detail. PP is the interior of the fort, called the *parade*; or in fortified cities, it is the space occupied by the city, leaving a narrow space between the buildings and the enclosing fort. The dark space XX is the main *ditch*, immediately outside of the scarp wall, and usually dug much lower than the parade. Between the ditch and the parade is the *rampart*, which forms the enclosure of the fort, and of which the scarp wall forms the exterior face. The rampart is raised

Fig. 1.

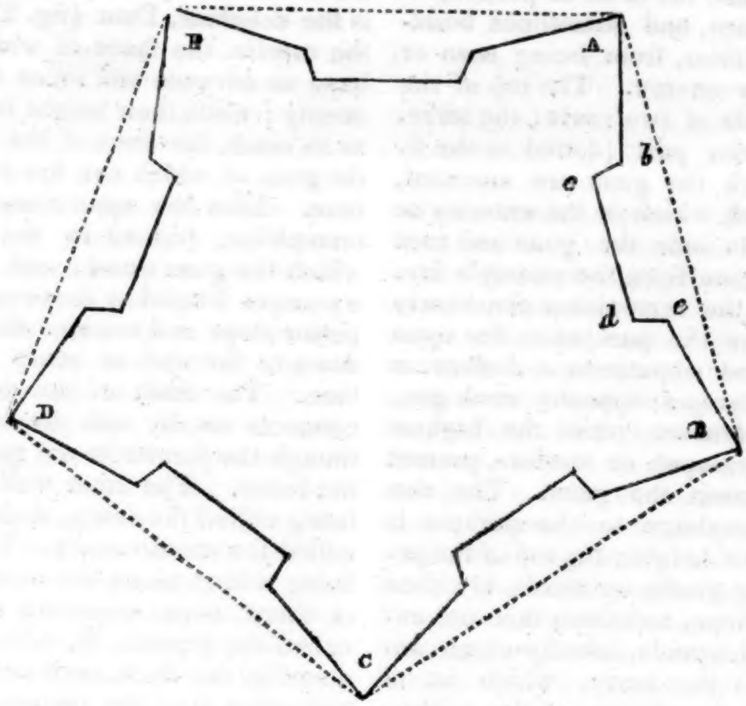
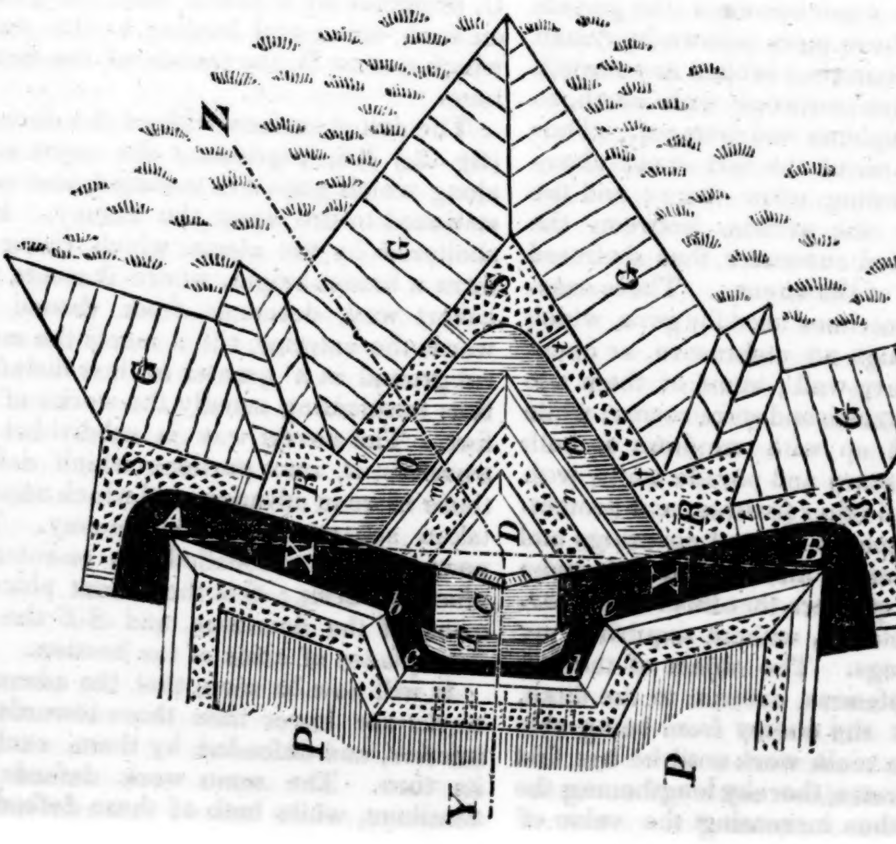


Fig. 2.

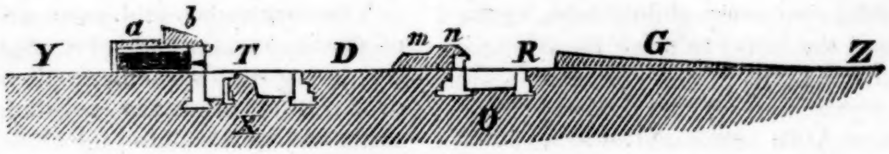


much higher than the ditch or parade, so as to protect men, and sometimes buildings in the interior, from being seen or fired on by the enemy. The top of the rampart consists of two parts; the *terrepleine*, or interior part, (dotted in the figure,) on which the guns are mounted, and the *parapet*, which is the exterior or highest part, to hide the guns and men on the terrepleine from the enemy's fire. The guns on the terrepleine can barely be pointed over the parapet to fire upon the enemy, and sometimes a hollow is made in the parapet opposite each gun, called an *embrasure*, while the highest parts of the parapet, or *merlons*, protect the men between the guns. The rise from the terrepleine to the parapet is called the breast-height; the top of the parapet declining gently outwards, is called the superior slope, and from this the exterior slope descends, usually at an angle of 45°, to the scarp, which is, of course, lower than the top of the earthen parapet. Instead of making the rampart a solid mass of earth, it is customary, in important forts, to construct vaults or rooms in it, to protect the men during a siege. *Piers* are run back from the scarp to the interior of the rampart, which in this case becomes the *parade wall*, and on these piers (shown by dotted lines on the curtain,) arches are turned, which are then covered with earth, to form the terrepleine and parapet. Thus the upper guns of the fort stand above the arches, resting upon them; and the rooms under the arches, between the piers, are called *casemates*, thus sheltered from all fires of the enemy. These casemates are sometimes used for guns, which then fire through an embrasure, or opening in the scarp wall; some of them are used for magazines and store rooms; while others, fitted up with windows at both ends, in the scarp and parade walls, with fireplaces and other fixtures, and protected from dampness by lead coverings and heated currents of air, are found to make comfortable quarters for officers, and barracks for soldiers, without requiring any other buildings. The object of the *outworks*, or defences, exterior to the ditch, is to prevent the enemy from being able to attack the main work until he has first taken the former, thereby lengthening the siege, and thus increasing the value of the fort. The principal of the outworks is the *demilune*, Dmn (fig. 2), called also the *ravelin*, the faces of which, *m* and *n*, have an advance and cross fire upon the enemy; while their height is not so great as to mask the fires of the main work, the guns of which can fire over the demilune. Like the main rampart, it has a terrepleine, (dotted in the figure,) on which the guns stand; and outside of it a parapet formed by the breast-height, superior slope and exterior slope, extending down to the wall or scarp of the demilune. The ditch of the demilune, OO, connects usually with the main ditch XX, though the former is not quite so deep as the latter. The inner wall of the ditches being called the scarp, their outer wall is called the *counter-scarp*. The main ditch being widest along the curtain, the scarp is there most exposed; a small work called the *tenaille*, T, is frequently introduced in the ditch, high enough to shelter the scarp from the enemy. Behind the tenaille, and in the middle of the curtain, is the *postern*, or arched gateway, which communicates between the main ditch and the interior main work or body of the place. There is also an arched passage under the tenaille, to the *double caponnier* C, protected by a raised bank or *glacis* on each side; and leading to the stairs which rise to D, the parade of the demilune.

The dotted surface without the ditches, (fig. 2,) RS, represents the *covert way*, along which guns are mounted, and men stationed to fire upon the enemy. It is sheltered by the glacis, which rising to form a breast-height, where it meets the covert way, descends from thence towards the exterior, till it meets the natural ground at a greater or less distance, thus terminating usually the works of the fort. The covert way is subdivided by *traverses*, *tt*, into portions which defend those more in advance, and which must be taken separately by the enemy. The portions, RR, are called the re-entering *places of arms*; S is the salient place of arms of the demilune, and S S the salient places of arms of the bastion.

It will now be seen, that the advanced works are lower than those towards the interior, and defended by them, each in its turn. The main work defends the demilune, while both of these defend the

Fig. 3.



covert way; and all three can fire upon the glacis at the same time. The advanced works are overlooked, or, in military language, *commanded* by those in rear; and there is no point in or near the fort where an enemy can shelter himself from its fires. The relative *relief*, or height of the works one above another, is shown in fig. 3, which represents a section or vertical cut through the fort, along the imaginary line YZ. Y is the parade; *ab* the rampart, with the parade and scarp walls—*a* the terrepleine, and *b* the parapet; the casemate underneath being in black, the arch over it in white, and the earth above shaded with oblique lines. X is the main ditch, in which is placed the tenaille T. D is the demilune; *m* its terrepleine, and *n* its parapet. O is the ditch of the demilune, R the covert way, G the glacis, and Z the natural ground on the exterior of the fort.

A fortress thus constructed is secure from being taken by storm or surprise, so long as it is vigilantly guarded. The only means of taking it is by the process of a regular siege. We have not time to give a detailed description of all the operations which this requires, both for the attack and defence. Suffice it to say, that the enemy begins by surrounding or *investing* the fort with a large army, protecting himself from the sorties of the garrison by lines of *circumvallation;* and, if necessary, constructing lines of *countervallation* to protect himself from any distant army coming to break his lines and relieve the garrison. Thus the garrison is completely hemmed in, and cut off from all farther supplies of men, ammunition, or provisions, except what it has in the fort. The enemy next advances near the fort on what he supposes to be the weakest side, and there, under cover of the night, digs a trench to shelter his men, called the *first parallel.* This parallel is often more than a mile long, and in a circular line around that side of the fort, six hundred or eight hundred yards distant from it; it being too dangerous to advance nearer at first. Having finished this parallel, a strong guard is placed in it to defend the sappers, who now dig trenches from this parallel, advancing towards the fort, called *boyaux.* These trenches run not directly towards the fort, for then they would be swept or enfiladed by its fires; but they incline for a short distance, a little to the right of the fort, and then a little to the left, in a zig-zag line. When the *boyaux* are extended nearly half way from the first parallel to the fort, a second parallel is dug, to which the guard are then advanced to protect the sappers while they advance still further. In this manner the third or fourth parallel will bring them close to the crest of the glacis, or to the covert way of the fort. Before this time, however, they will have erected batteries to fire against the fort, and destroy or silence its guns. The *ricochet* fires, where the ball, after first striking is made to rebound and strike several times successively, are the most effective for this purpose. The enemy will now, either by sapping or by storm, dig a trench along the crest or top of the glacis, in which to defend himself and erect new batteries to batter down the walls of the fort. This operation is called *crowning the covert way*, as the garrison can no longer hold it, but are obliged to retreat to the demilune. The enemy's batteries will now endeavor to effect a breach in the scarp of both the demilune and the salient of one of the bastions; so that the earth falling down may produce a gentle slope, by which to ascend to storm the fort. Meanwhile a gallery will be constructed, descending from the glacis under the covert way to the foot of the counter-scarp, so that the enemy may enter the ditch thereby, and cross it to the assault. As soon as the demilune is taken, the enemy will shelter himself in it, by digging a trench and throwing up the earth before him for a protection, as in the parallels. At length, the breach in the main work being effected, the enemy will mount to the assault, un-

less the garrison prefer to capitulate and resign the fortress to the besiegers, or unless a relieving army should have arrived to compel the latter to raise the siege.—[Scientific Tracts.]

PRUSSIC ACID FOR KILLING WHALES.—Mr. Dexter H. Chamberlain, an uncommonly ingenious mechanic of Boston, who some time since produced the machine for manufacturing hooks and eyes with extraordinary exactness and rapidity, has devised a scheme for killing whales, so very novel, and yet, theoretically, so very certain, that it promises to produce an entire revolution in that laborious and truly hazardous employment. It is familiarly known, that after a harpoon is thrust into the great monster of the ocean, he runs till exhausted by the loss of blood; in a word, the boat's crew must wait till he bleeds to death. The sacrifice of life in following a wounded whale, towed as the boat is, by the frightened, wounded, and enraged animal, is sometimes melancholy in the extreme. At any rate, there is a considerable loss of time in this part of the business, and not unfrequently, a total loss of the whale, in consequence of not giving a mortal wound.

To obviate all these difficulties, Mr. Chamberlain has constructed a harpoon upon a new principle, which conveys to the bottom of the incision a small vial of *prussic acid*,—the most deadly of all the known poisons, inasmuch as the vital energies seem to be overthrown very soon after this horrible liquid is brought in contact with the blood. The harpooner, as is customary, will throw the instrument with all his might, without regard to the spot—for his object is to inject the poison. When the whale starts, by re-acting on the line attached to the harpoon, the vial is instantly crushed, and death let loose within his mighty frame. There can be no redemption for the whale—die he must, and that quickly, for he is a warm-blooded animal.

Mr. Chamberlain has secured a patent, we understand, and deserves a generous reward for this unique discovery, which, while it tends to lessen physical suffering, an object of the highest moment to the humanely disposed, affords the most certain success to the operations of the whalemen.—[Ibid.]

[From Porter's Chemistry of the Arts.]

FURNACES IN GENERAL.

The principal and most critical parts of the apparatus subservient to chemistry, being the furnaces employed for the preparation of those substances which come within the chemical class, the structure of these is more complex, and the uses they are applied to of a more nice and difficult nature, by far, than any other of the operations regarding that art. It is, therefore, necessary that they should be well designed, and judiciously executed. Otherwise their defects greatly enhance the expense, and frustrate the intention of the operations they are to perform; besides their being extremely liable to become in a very short time out of repair, and uselessly ruinous.

It is also proper that careful and able men should be employed in the fabrication of furnaces, though such are rarely to be found among common workmen. But the most likely to succeed are those who have either been employed before in the same business, or have been accustomed to set coppers for household purposes. When the best qualified, however, are set to work, they should be continually superintended by the operator, or some person capable of judging, both of their adherence to the plan given and general performance of the work. For if the parts of furnaces that are exposed to much heat be not made extremely compact, but are patched up of mortar and bricks that are not fitted in every part to each other, as bricklayers are very apt to do from the habits they acquire by being employed in coarser buildings, the mortar will very soon calcine, and shrink in such faulty places, and make such vacuities and inlets to the air as render the furnace incapable of doing properly its office, to the great delay, and sometimes destruction, of the process.

The materials are the next object of attention; and they ought to be well chosen, and perfect of their kind. Common bricks, with good mortar, made with lime and coal ashes, well mixed and beaten together, will serve for those parts which are not liable to be heated red hot; but where that degree of heat, or a greater, may happen, Windsor bricks, and Windsor loam, or Stourbridge clay; and where

the fire may be very violent, the composition called the fire lute, hereafter mentioned, should be used. And as the Windsor bricks are of a texture which admits of it, they should be so ground to fit each other, as to form one compact body, with scarcely any interstices at all.*

Particular care should be likewise taken in the drying of furnaces, for the best designed or constructed may be easily spoiled by any mismanagement in this point; and this is very frequently the case. Where the use of them is wanted, as generally happens, before they are ready, they are not allowed a proper time. The interior part should be therefore suffered to settle and dry for some days before the cavity be closed in by finishing the upper; and after that part also is become pretty firm, they should be gradually warmed by a small charcoal fire, made either in the body of the furnace itself, or in the ash-hole under it. After this has been some time continued, and the mortar appears hard in the inward surface, a coal or wood fire may be made, of a gentle degree at first, and increased slowly, as the smoking of the furnace may indicate to be proper. But the more leisurely this proceeds, the more durable and perfect will be the furnace.

Notwithstanding the great importance of commodious furnaces to the practice of chemistry and pharmacy, the methods in general used for their construction are surprisingly defective. Several errors committed with regard to them are here hinted, and on what principle they may be avoided; the remedy however in each case will be reserved, till the improved plan for the construction of the several particular kinds is given.

"The first and most obvious fault is the disposing the fireplace in the front of the furnace, instead of putting it under the centre of the pot intended to be heated; by which means the fire exerts its greatest force on the column of brick over it, calcining and destroying all that part of the furnace, without an equivalent effect on what it is intended to act upon. This improper disposition of the fire may, however, be easily avoided; and a right situation substituted, if the worm flue, improperly used in common, be omitted, and the other methods followed, which are given in the particular plans. And as the inconveniences resulting from this error extend as well to the fire-places of stills and boilers as of other furnaces, an undue consumption of fuel, and quick destruction of the furnace, being always disadvantageous, it will be found beneficial to endeavor to remove them in all cases; especially as it may be done without producing any other incommodious consequence, except where immensely large vessels are in use, which unavoidably require a support of brickwork under them.

"Another great error in the building of furnaces, particularly those for pots or stills, is, as has been hinted, the carrying the fire around the vessel to be heated, in a vermicular flue, or worm, as it is commonly called, by which means the vessel intended to be heated is much longer in attaining a due degree of heat, as the principal force of the fire is exercised upon that great mass of brickwork which forms the worm, and is brought into equal contiguity with the vessel itself, in respect to the fire, with indeed a much greater surface exposed to it; from whence it requires a proportionable quantity of fire to keep the whole in any stated degree of heat.

"Besides the great delay, therefore, in the beginning of the operation, which cannot proceed till the whole mass that makes the worm be brought to a certain heat, the due effect cannot be had, without the consuming a much greater proportion of fuel than if the heated vessel hung in the open furnace.

"But there is yet another momentous inconvenience arising from furnaces of this kind of structure, where a strong heat is wanted, which is, that the brickwork of these worms is extremely subject to be damaged, and fall to pieces, from whence, the flue being choked up, and the draught obstructed, a necessity arises of taking down all that part, if not the whole of the furnace, and rebuilding it at a great expense, as there is no possibility of repairing it under these circumstances.

"An entire open cavity, carried round the pot, still, &c. formed by raising the

* The clay obtained at South Amboy, N. J., answers the best purpose for fire bricks of any that I have met with in this country, but is inferior, I believe, to the Stourbridge clay.—[Am. Editor.]

brick-work, at an equal distance, on every side, and closing it in where no farther heat is required, answers the end much better. It suffers the proper object to be immediately surrounded by the fire, and places it out of the contact of other bodies, so as to be capable of being independently heated; while the furnace itself is much less liable to be damaged, or can sustain a small degree of damage, without any material injury to its use, and even when it is injured so as to require repairing, admits of it with greatly less trouble and expense than when built in the other method."

Principles of constructing Furnaces.—The importance of furnaces in the practice of chemistry is so great that the principles on which they are to be constructed ought to be carefully studied, in order to be able to adapt them to the purpose the artist designs. Furnaces consist of a variety of parts, namely: 1st, the twere, or entrance for air; 2d, a room to receive the ashes of the fuel; 3d, an ash-room entrance, by which the ashes may be extracted; 4th, a grate to support the fuel; 5th, a fire-room, to hold the burning fuel; 6th, a feeding door, by which fresh fuel may be added as often as is necessary; 7th, a stoking door, by which the fuel is managed; 8th, the throat or bridge, by which the flame and heated air are admitted into the laboratory or chamber of the furnace; 9th, the laboratory or chamber, containing the vessels and materials to be acted upon by the fire; 10th, the entrance into or out of the chamber; 11th, the vent by which the flame and heated air passes out of the chamber into the flue of the chimney; and, finally, 12th, the chimney to carry off the heated air and smoke into the atmosphere.

All these twelve parts are not to be found in every furnace, three of them only being essential to the very idea of a furnace; namely, the twere or entrance for air, the fire-room, and the vent.

The Twere.—The twere, or entrance for air, is generally made to open into the ash-room, but sometimes into the fire-room itself. When it is intended to admit the atmospheric air by the unassisted pressure of the latter, as in what are called air furnaces, it should be made as far beneath the level of the grate as the situation will allow. In some cases it is made to open out of a deep vault, or long subterraneous passage, or a hole being cut in the wall of the laboratory, an iron pipe is laid down so as to allow a current of cool air to flow from the outside of the laboratory into the furnace; the outer mouth of this pipe is frequently made conical.

The entrance of the air in air furnaces should in all cases be regulated, or, at least, be capable of being stopped altogether whenever it is judged requisite. Various methods are used for this purpose. The oldest, and, when the twere is not too large, still the best, is merely to heap up ashes against the twere, and to regulate the opening by means of a poker or spatula; at present an iron door is more generally used, which is opened more or less as occasion requires. Some chemists use a series of circular holes, having their diameters in geometric progression, 1, 2, 4, 8, 16, &c., with stoppers fitted to them, as Dr. Black, in his original furnace; others use one or two slides moving in grooves, and there is now sold in London a circular slide invented by Count Rumford.

In general, the entrance for air in air furnaces is made much too large, so that the velocity of the air being diminished, it becomes much heated in its passage, expands, and thus a less weight of it is presented to the fuel. The area of the entrance ought to be regulated by the sum of the areas left open between the bars of the grate, and its area should not exceed two thirds of those open spaces, in order that the air may strike against the grate with some degree of force.

Blast furnaces are those in which a large quantity of air is supplied, by means of mechanical contrivances, than would pass through the fire by the unassisted pressure of the atmosphere. The air is made to enter the furnace by means of one or more pipes leading from the bellows or other blowing machine. In the small blast furnaces used by experimentalists, assayers, and other metallurgic artists, the twere is made no larger than barely to admit the blast pipe, and the crevices, if any are left, are usually stopped with soft clay; but in the large blast furnaces of the iron works this is not the case; and it is said, that even in small blast furnaces there is some advan-

tage in not being solicitous about closing the space between the blast-pipe and the sides of the twere.

The Ash-room.—In regard to the ash-room, no particular observations occur, except that in the small blast furnaces of the French experimental laboratories it is now divided horizontally in two parts by a plate of earthen ware pierced by a circular row of holes, the object of which is to equalize the blast of air so that it may strike against all parts of the grate with equal force.

The ash-room is indeed frequently sunk into the ground, in order that the other parts of the furnace may not be raised too high for the purposes for which they are designed, and hence is often called an *ash-pit,* although it may really be above the level of the ground. A proper ash-pit, if small, must have a sloping floor, that the ashes may be easier drawn out; or, if large, steps are made into it to allow the operator a free passage to the door. The cavity made by this slope, or the steps, is sometimes, as by the founders, covered over with an iron grating, or by a trap door, with holes bored in it to admit the air. In this case, as the ash-room door could not be well got at, even if the furnace was provided with it, an iron plate, or loose board, may be used to cover more or less of the grating, or trap door, and thus regulate the draught, or stop it entirely.

The Ash-room Entrance.—The ash-room entrance is generally united with the entrance for air in air furnaces; but it is far better to have them separate, and to keep this entrance constantly shut by a door, and this the more especially, because it will very frequently happen that the position of the one is unfavorable for the other. Count Rumford's circular slide is usually fixed in an iron door for this entrance.

The Grate.—The grate is one of the most important parts of an air furnace. In small furnaces it is frequently of pig iron, and cast in a single piece, but in the larger grates each bar is cast separate, and has a shoulder at each end, and sometimes when they are two feet or more in length, they have also another shoulder in the middle, by which they are made to keep at a proper distance from each other. The bars are from one inch and a half to three inches deep, according to their length, and about one inch thick. They are put in so as to rest loosely upon bearing bars, placed across the top of the ash-pit, that they may be taken out easily, and renewed if it be necessary.

In the furnaces intended for boiling water, or a similar heat, a distance of half an inch between the bars is sufficient. In those for greater heats, as in distilling, with earthen retorts or iron cylinders, the distance should be about three quarters of an inch, and in melting furnaces a full inch.

When furnaces are used to heat steam-boilers, brewers' coppers, stills for ardent spirits, or evaporating pans in salt works, alum works, or the like, the grates are usually made of greater extent, in order to expose a large surface of the heated fuel, even to the extent of four or six feet square, and it is computed, that with half inch spaces between the bars, each square foot of the grate will consume about 11 pounds of Newcastle coal every hour. Now, although these large grates are laid sloping down towards the back of the furnace at an angle of twenty, or even thirty degrees, or with a fall of from five to seven inches and a quarter in each foot, yet there is a difficulty of spreading the coals equally over the surface of such large grates; and the coals also run into large masses of clinkers, which are very troublesome to extract out of the fire.

When the purposes for which a furnace is constructed are such that a small fire is required at one time, and the heat must be vehement at another, Dr. Bryan Higgins used loose iron bars, an inch square, instead of a grate. For a moderate fire, so many of these bars were placed upon the bearing bars fixed in the walls of the furnace as to leave interstices of half an inch between them. When the fire required to be increased, one or two of the bars were withdrawn, and those left on the bearers arranged at equal distances by the poker. If by chance any accident happened which required the fire to be suddenly stopped, the whole of the bars being withdrawn, the fuel descended at once into the ash-room.

The Fire-Room.—In respect to the fire-room, the principal care is to surround it with those substances which conduct heat

the slowest, in order to prevent the fuel being expended in waste. The side walls should therefore be double, with a space of about two inches and a half between them; the two walls being tied together, as the bricklayers express it, by bricks from space to space, and this may either be left empty, or filled with ground charcoal or coke.

[Wood ashes are preferable for this purpose; its non-conducting powers are nearly equal to those of charcoal, and it is not liable to be burnt out by exposure to the air through the chinks, which are constantly occurring in the walls of furnaces which are subjected to high heats.]

The inner wall must be constructed of such bricks as will bear the action of fire without running into glass; and these must be set in an argillaceous cement of a similar nature, and commonly called fire lute.

The fire-rooms of portable furnaces, which in England are usually made of iron plate, are in like manner lined next the iron with charcoal powder, made into a consistent mass with clay water, and next the fire, either with fire bricks, fire lute, or a mixture of charcoal or coke powder, with any clay that will bear the fire. Sage has recommended asbestos, ground, and mixed into a paste with the mucilage of gum tragacanth, for the composition of portable furnaces.

With a view to avoid both the inconveniences lately mentioned as incident to large grates, Mr. Losh, of Point Pleasant, Northumberland, in a patent which he took out in 1815, recommends for furnaces of the kind there mentioned, the use of two or more, even as far as six grates, with as many separate fire-rooms; and he avers, that from his long experience in the management of a large chemical manufactory, that this plan is attended with a great saving of fuel, and the boiling, generating of steam, distillation, and evaporation, goes on in a more equable manner; and also that the manual labor of the stoker is considerably less when several small fires are used to heat these great pots than when only a single immense fire is to be minded; to which there may also be added the facility of repairing the fire-places without stopping the operations.

There is another view with which two grates and as many separate fire-rooms are constructed under large boilers. These furnaces require a copious supply of fuel, which is generally raw coal, and emits of course a large quantity of black smoke every time a fresh supply of coal is put upon the fire, to the great annoyance of the neighborhood.

With a view to get rid of this inconvenience two plans have been adopted. Mr. Watt, in 1785, constructed a small second fire-room and grate between the principal fire-room and the chimney, in which he kept a small fire of cinders, coke, or other clear burning fuel, in order that the smoke as it passed over this clear fire might be burned; but this plan has not been found to answer completely, as the necessary supply of air for the combustion of the smoke could not be supplied through this small secondary grate.

Lately, Mr. Newman has proposed another somewhat similar construction. He builds two fire-rooms and grates side by side, which communicate with each other; each of these fire-rooms has a vent into the chimney, which can be opened or stopped at pleasure. Supposing, then, a fire is made in both fire-rooms, and the vent belonging to the fire-room A is open, and that of B shut, the smoke generated on adding fresh fuel to B, will have to pass over the surface of the fire in A, and thus be burnt for the most part in its passage. The next parcel of fuel is to be supplied to the fire-room A, and for this purpose the vent of the fire-room B is to be first opened, then that of A closed, and lastly the fuel supplied, the smoke from which will then be obliged to pass over the surface of the fire in B. In this alternate mode the two fires are to be supplied, and the smoke from the one made to pass over the other.

Stoking Hole.—A stoking hole is necessary in furnaces for lighting the fire, and extracting the clinkers that are formed. For the convenient performance of these purposes, this hole must be on a level with the grate, or nearly so; and if the grate is formed of loose bars, which are to be occasionally pulled out, or put in, as a greater or less degree of heat is required, it should descend a little below the grate, to give room for this purpose.

This hole is generally closed by an iron door lined with clay, or a piece of fire stone. For the purpose of ascertaining when the fire wants stirring, or replenishing, a hole about an inch in diameter, and covered by a piece of iron, which hangs loose by a rivet above, is sometimes made in this door.

Feeding Hole.—The feeding hole, by which fuel is supplied to the fire-room, is usually on the side, a little above the height to which the fuel reaches, but sometimes on the top of the fire-room. It should be made large, that a considerable quantity of fuel may be added at once, and thus the frequent opening of this hole, and the consequent cooling of the interior of the furnace, be prevented.

This opening is very often closed by means of a door hung on hinges, or sliding up and down, being supported by a counter weight; sometimes a stopper is used, but these are apt to stick; the door or stopper is usually made of iron, and lined with fire lute, or in small furnaces the stoppers are made of clay.

Sometimes what is now called a *hopper* is used, which is made of cast iron plates, and set rather sloping in the furnace. This being filled with coal, has its outer end stopped up with small caking coal, and as the fuel in the fire-room is consumed, that in the hopper is pushed in to supply its place, care being taken respecting the keeping of the outer end stopped by the small coal.

Even in this method of feeding the fire, cold air is necessarily admitted, and the interior of the furnace cooled in consequence; so that although hot air be admitted into the chamber, yet the smoke will not take fire until some time after the coals have been added.

To avoid this inconvenience, close hoppers have been contrived with a moveable bottom, formed either of a sliding plate, or one moving on a hinge and held up by a counter weight equal in effect to the weight of the coal contained at any one time in the hopper, which is closed at top by an iron lid shutting very close. This close hopper, being built in the furnace, directly over the fire-room, or at least the front part of it, is filled with coal, the lid shut down, and when the fire wants replenishing, the bottom is opened, and the coal of course falls down on the fire, without the introduction of any cold air to cool the interior of the furnace.

When this mode of feeding is adopted, it will be advisable, just before the letting fall of the fresh coal, to push that already in the furnace towards the back by means of an iron hoe, as wide as the fire-room, and about four inches deep, with a long iron handle passing through a hole in the bottom of the stoking door, and which hoe remains constantly in the furnace, being pulled up close to the stoking door, before the fresh coal is let fall.

A feeding hole, distinct from the stoking hole, is seldom used in England, notwithstanding its advantages were set forth by Mr. Dossie, in his "Elaboratory Laid Open," fifty years ago. He very justly observed, that if the fuel can only be thrown in at the stoking hole, there exists a necessity for having the area of the fire-place large, since otherwise a sufficient quantity of fuel cannot be made to lie upon it. For if the grate be small, the coals tumble out, whenever it is filled to any great height, every time the door is opened.

Now the disadvantages consequential to the having the fire-place too large are manifold; for if the space occupied by the bars be great, and the whole area they make be covered with coals, the heat will be too strong on many occasions.

If the whole area be not covered, a false draught is made through the uncovered part, which greatly weakens both the degree and effect of the fire proportionably to the quantity of fuel. As the influx of the air will be the greatest through the naked part of the area, which much weakens the draught through the coals, at the same time it greatly refrigerates both the furnace and its contents; so that not only a great waste of fuel is in such case made, but the latitude in the degree of heat, and means of accommodating it to the occasion, which are to be completely had in furnaces well constructed, are hereby greatly limited. This defect may, he observed, be remedied by making a proper feeding hole, sloping slightly towards the fire, some inches above the surface of the fuel, when at the highest.

Through this hole the fire may be fed by a shovel of a fit size and figure, or

stirred with a poker, properly bent, without using the door for those purposes, which need, therefore, only be opened for the making or lighting the fire, or freeing the bars from the scoria or clinkers, when they are choked up with them.

This manner of feeding the fire will be found a very great convenience to those who are accustomed to it. As the effectual draught of the furnace may be thence greatly increased, the lighting the fire much facilitated, and the operator likewise enabled to have what body of fuel he pleases in the furnace, and to adequate the heat with certainty to any occasion, without either being subject to have the fire extinguished when it is kept low, or not to admit of being raised high, with the falling out of the coals, already in the furnace, every time he attempts to throw in a fresh supply.

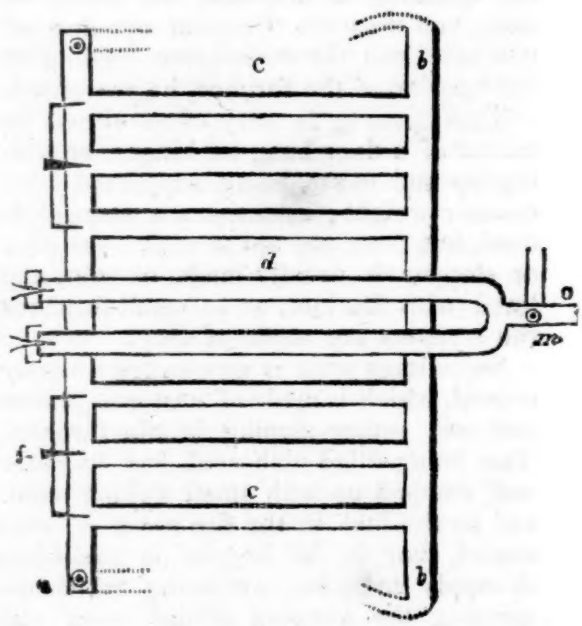
When this device is used, the usual area of the bars may be diminished at least one half; and the consumption of fuel will be lessened much more than in that proportion, for the reasons before given. The operation will not be soon checked, on any neglect in keeping up the fire, which is liable to happen when furnaces are built in the common way.

The Throat.—In many furnaces there is no visible throat between the fire-room and chamber; the walls of the two rooms being continued in a line. In some, however, the separation is very distinct, and the throat is either a simple opening, the lower limit of which when on the side is usually called the bridge, or instead thereof, a number of small holes disposed generally in a quincuncial order, or chequerways, by which arrangement the distribution of the heat through the chamber is rendered more equal than when only a single opening is used. In this case care must be taken that the sum of the area of these holes shall not exceed that of the free space between the bars of the grate, otherwise the desired equal distribution of the heat cannot be obtained.

[From the London Mechanics' Magazine.]

Improvement in the Fire Bars of Locomotive Engines.

SIR,—The Rev. Dr. Lardner, in his evidence given before the Select Committee, says, "that he has witnessed a new set of grate bars melted in a single trip between Manchester and Liverpool." From this I conclude that the fire bars of locomotive engines are generally red hot; and supposing this conclusion to be correct, it strikes me that the red hot bars may be rendered of use to the engine—first, by increasing the energy of the fire, should the steam flag on the ascent of long hills, or in going over heavy roads; and, second, by producing a brilliant light, when locomotives undertake night journeys. Both these objects I propose to effect, by using hollow fire bars, and making them serve as so many small oil-gas retorts; or at other times permitting the air to pass through them to the furnace.



Suppose the front bar *a*, and back bar of the grate *b*, hollow, and of larger dimensions than the hollow fire bars *c c c*, all which open into them, except the two centre bars *d d*, which pass through both. In the front bar *a*, just opposite each fire bar, are entered jet points *f*, connected with a small forcing pump, with which the attendant may alternately inject oil into the bars on the right and left of the centre; which oil being converted into gas will pass into the bar *b*, from each end of which a pipe should pass upwards to the side or front of the furnace, as the form of the boiler may render most advisable. Previously to injecting the oil, the valves *e*, in the bar *a*, should be screwed down to prevent the air from entering. A pipe from each end of *a* should be carried down, and then to the forepart of the carriage, and end in a funnel.

To supply the gas for lighting the carriage, let the two centre bars, after passing through the back bar *b*, be united. There may be placed at *m* a three-way cock, to al-

low the passage of the air through the pipes by day, when the jet caps are unscrewed; and a communication may be opened by the pipe *o*, (which should pass through the cold water supply tank,) with the gas holder, during the night, the oil to be injected into the bars, *d d*, alternately by the engine.

I remain, sir, yours respectfully,

J. R. White.

Wells, Somerset, Feb. 24, 1835.

P. S.—Has not Colonel Macerone given us a pretty good hint of the manner in which Dr. Church effects his condensation? There must certainly be some strong resemblance between Mr. Hall's mode and Dr. Church's. Since speaking of one leads to mentioning the other, why not place Hall's fascine of condensing tube horizontally, and supply the place of water with an air draught or blast to the furnace, thus warming the air and condensing the steam? J. R. W.

[From the Journal of the Franklin Institute.]

Report to the Board of Directors of Bridges, Public Roads, and Mines, upon the Use of Heated Air in the Iron Works of Scotland and England. By M. Dufrenoy, *Engineer of Mines. Paris,* 1834.

(Continued from vol. v., page 328.)

ENVIRONS OF DERBY.

The coal basin of Derby, a prolongation of that of Sheffield, contains many large iron works; three of them, the Butterly, Codnor Park, and Alpdon works, have adopted the hot air blast. I visited the first two, under the charge of Mr. Jessop, one of the most intelligent iron masters in the kingdom. The heating apparatus of all these differ from those I have described, and, in some essential respects, from each other. For this reason, I have deemed it proper to describe them in detail, though the results which they give are not so favorable as those obtained at the Calder works.

Butterly Iron Works contains three smelting furnaces. The iron there made is intended for castings, either of first or second runnings. One furnace only was in blast when I visited Derbyshire. The air for the blast was heated by an apparatus at each tuyere; this apparatus was composed of the large pipes, A B C, (figs. 11 and 12,) 27 inches diameter in the clear, placed horizontally one over the other, and separated by arched plates, *m n, m' n'*. These pipes are connected in pairs, by elbow pipes, *d e, d' e'*. The air from the blast engine enters by the pipe *c*, and makes its exit at *g*, after having passed the length of the three pipes successively. The joints are placed on the outside of the furnace proper; but to prevent the air being cooled in traversing the elbows, they are cased in brick-work.

The elbows connecting the long pipes are in plates, connected by bolts and nuts, passing through lugs, or flanges. The pipes are one and a half inches thick, and rest upon fire lumps, *t t*, placed at proper distances upon the arch plates, *m n, m' n'*. This disposition allows the flame to envelope them on all sides.

The first pipe, A, is not exposed directly to the action of the fire; it is separated from the grate by an arch of brick, extending the whole length of the furnace, which allows the flame to pass by the flues, *v v*. The partitions, *m* and *n*, have openings, *p* and *q*, placed at the opposite ends of the furnace, so as to compel the flame to traverse the whole length, without escaping from one story to another. All the arches are of fire brick, one brick thick. The expenditure of this apparatus is 62 cwt. for each ton of casting made. The air is raised to 360° Fahr. Notwithstanding the feeble temperature, a great economy of fuel is effected, as indicated below.

Consumption and products during the first week in July, 1830, from furnace No. 2, worked with cold air, 159 tons 5 cwt. of coke,—corresponding to 218 tons 10 cwt. of coal, 109 tons 17 cwt. of ore, and 35 tons of flux,—produced 83 tons metal.

Consumption and products of furnace No. 2, on the 17th of July, 1833, heated air being used: The furnace received forty-one charges, each composed of 9 cwt. crude coal, 9 cwt. ore roasted, and 3 cwt. flux. The average of the first fortnight in July had been forty charges per day, and the iron produced seven tons.

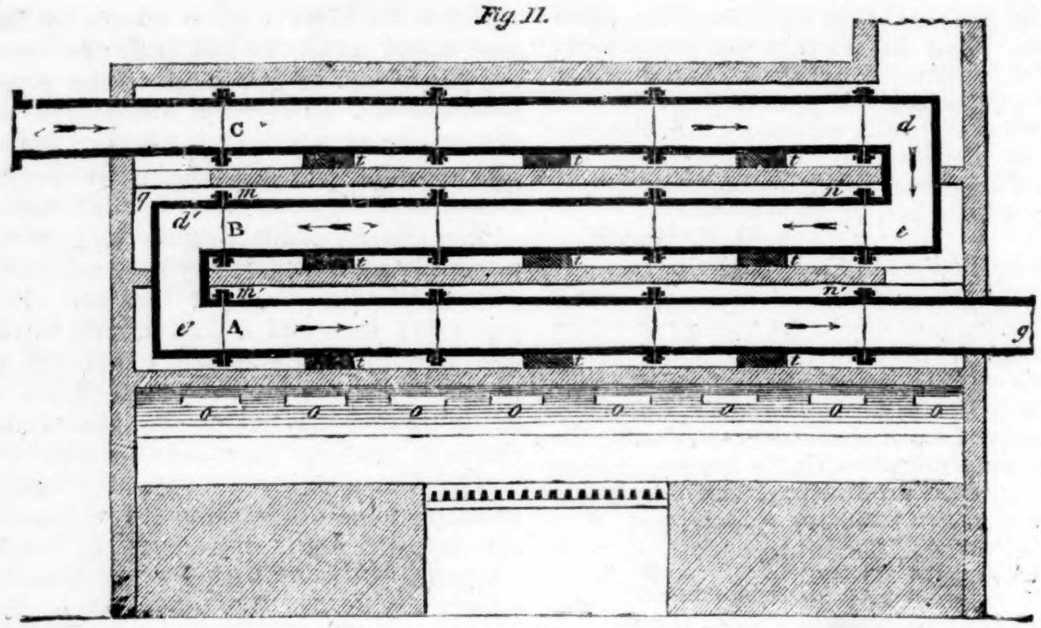
Upon comparing, from these data, the consumption of the two periods, one ton of iron required as follows:

1830. Cold air and coke—Coal, 5 tons 16 cwt.; ore, 3 tons; flux, 1 ton.

1833. Heated air and coal—Coal, 2 tons 18 cwt., including fuel to heat the air; ore, 2 tons 11 cwt.; flux, 1 ton.

To know the whole expense of fuel, that used by the blast engine must be added, for which I have no precise data;

Fig. 11.



but this expense must necessarily diminish in proportion to the increased yield of the furnace.

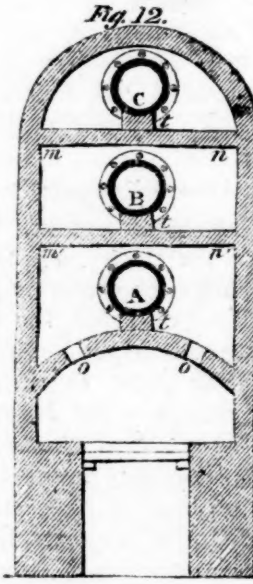
At Butterly, therefore, a saving of one half the fuel has been effected by the introduction of the new plan. The quantity of flux remains the same, because the sulphurous nature of the coal requires a large proportion of lime.

The blast engine, which served but two furnaces, now works three; but to obtain this increase, a larger cylinder was put in. Formerly, the cylinder was seventy inches in diameter, and eight feet stroke, working thirteen revolutions; now, the cylinder is eighty inches, the length of stroke and number of revolutions remaining the same.

The quantity of air expended, which was 2,500 cubic feet per minute, is now reduced to 2,160 feet; but the pressure, two and a half pounds to the inch, has undergone no variation. The opening at the mouth of the tuyere has been reduced from two and a half to three inches; the iron produced is intended for castings.

Codnor Park Works.—This work consists of three furnaces, three refineries, and a sufficient number of puddling furnaces to work up all the metal. These furnaces have worked for the past year with heated air and crude coal. The substitution of heated air has produced a saving of fuel similar to that stated for Butterly; 2 tons 9 cwt. being now sufficient to obtain one ton of metal, which formerly required five tons. It should be remarked, that the expense of coal has always been less at Codnor Park than at Butterly, on account of the difference in the quality of iron produced. This difference would be much more sensible, if the same quality of coal was used at both works; but at Codnor Park the soft coal is used, while at the other a variety called cherry coal is used, which better resists the action of the blast.

Fig. 12.



Consumption for one ton, using cold blast: Butterly, 5 tons 16 cwt.; Codnor Park, 5 tons.

Same with hot air—Butterly, for smelt-

Fig. 13.

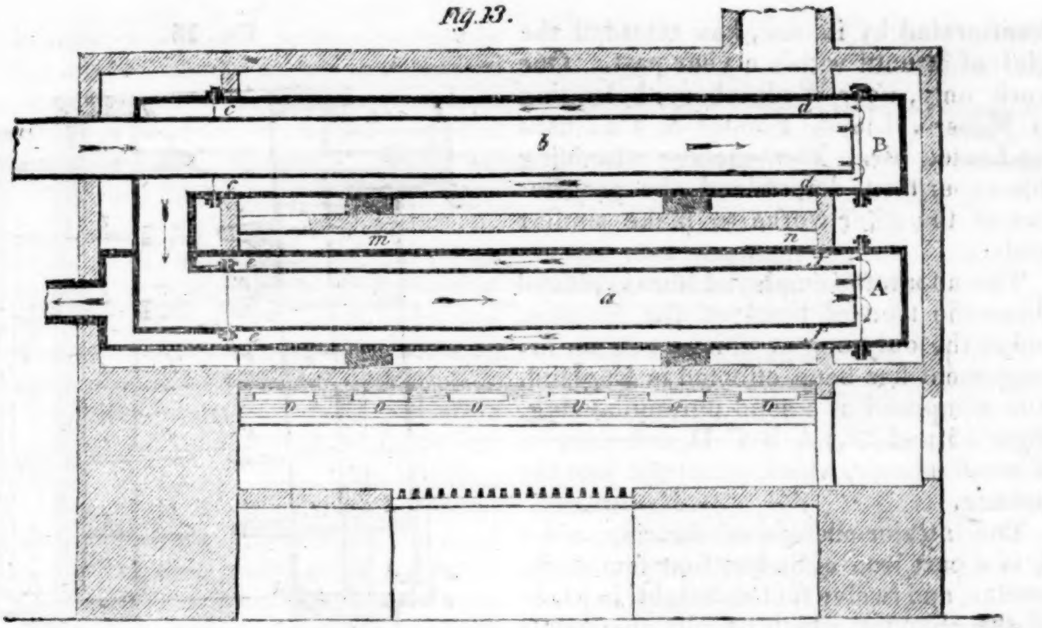
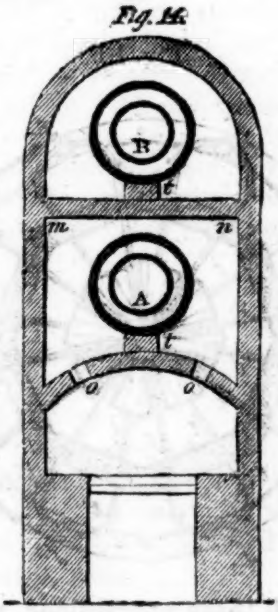


Fig. 14.



ing 2 tons 12 cwt., apparatus 6 cwt., total 2 tons 18 cwt.; Codnor Park, for smelting 2 tons 9 cwt., apparatus 6 cwt., total 2 tons 15 cwt.

The apparatus employed at Codnor Park, for heating the blast, is composed of two pipes, A and B (figs. 13 and 14,) placed one above the other, in which are inserted small pipes, *a b*, having the same centres as the large pipes, A and B. These pipes are connected by elbows, so that the air, in passing from the blast engine, through the interior pipe, *b*, spreads itself over the circular space, *c d*, between the pipes B and *b*; passing then into the second interior pipe, *a* is transmitted to the furnace by traversing the second circular space, A.

This disposition of double pipes, one within the other, was adopted to remedy a serious inconvenience experienced at Butterly,—an inconvenience incident to pipes of large diameter, in which the air being heated unequally, a current of cool air passes along the centre of the pipe, and renders it impossible to raise the temperature sufficiently.

The pipes, A B, are of cast-iron, thirty inches diameter outside, and one and a half inches thick; the small pipes, *a* and *b*, are of boiler iron, six-tenths of an inch thick, and eighteen inches diameter in the clear. The construction of the furnace is the same as at Butterly—figs. 13 and 14 giving an exact idea of it. The air is heated, by means of this apparatus, to 400° Fahr., with a consumption of 6 cwt. coal.

We have already stated that all the metal made at Codnor Park is made into malleable iron;* this iron is used in the machine shops of Mr. Jessop. It serves equally well for boiler iron for steam engines, which requires the very best metal.

ENVIRONS OF BIRMINGHAM.

The introduction of the hot air blast has scarcely commenced in the Staffordshire iron district, the opinion being still prevalent that the quality of the iron is

* This is an error, as large quantities of pipes are cast at this work for the London market.—[Trans.]

deteriorated by its use, has retarded the trial of it until within a year past. One work only, near Wednesbury, belonging to Messrs. Lloyd, Forster & Co., uses the heated air. The success attending this experiment determined the proprietors of the other works to make similar trials.

The apparatus employed here is placed above the trunnel head of the furnace, and is the only one at which such an arrangement has been effected in England. It is composed of a solid pyramidal ring, (figs. 15 and 16,) A B C D, and a series of small tubes, *t*, which penetrate into the furnace.

The interior surface of the ring, *a b c d*, is a cast iron cylinder, four feet in diameter, and twelve feet in height, in place of the chimney which usually surmounts the trunnel head of the furnace. The exterior surface of the pyramid is octagonal, and made of boiler plates, riveted together like a steam boiler, its diameter at the middle being six feet; a space is left between the surfaces of one foot on all sides; to protect the outer surface from the cooling action of the air, it is encased in brick-work.

The air, passing from the blast engine, is carried to the top of the furnace, circulates through the pipe, *e e e*, on a level with the top of the furnace, then divides itself among the eight vertical pipes, *f g*, placed round the outer surface of the casing, which are connected with the circular pipe; each of these vertical tubes communicates with the interior of the case, or pyramid, by six small tubes, which pass into projections within the interior of the furnace.

This part of the tubes, *t*, enters into the pipes, *t'*, closed at the extremity; so that the air, in moving, is forced to spread itself over the surface of the heater. These tubes, *t'*, are all of cast iron, and are connected with the distributing pipes, *f g*, by leather sleeves, *t''*.

The air, after being heated in the tubes, *t'*, and in the circular heater, A B C D, *a b c d*, re-ascends to the tuyeres by the opening, *v*. To prevent the air from cooling during the transit, the conductor is placed in the chimney of the steam boiler, twelve or fifteen feet distant; a kind of brick-work connects the furnace with this chimney.

Fig. 15.

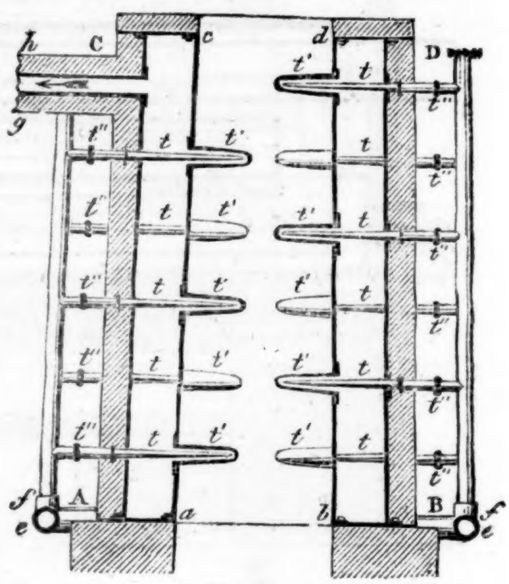
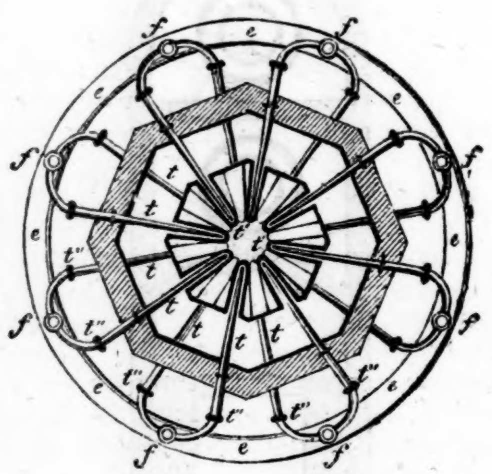


Fig. 16.



With all these precautions, the temperature of the blast cannot be raised higher than to 360° Fahr., and they are obliged to heat it again in a furnace, within a few feet of the embrasure of the furnace.

The consumption of this fire is nearly 4 cwt. of coal to the ton of iron.

This apparatus is very costly, and requires frequent repairs; the little saving of fuel effected by it, (about 3 cwt. of coal per ton of iron,) is more than compensated for by the expense of construction and repairs, and, above all, by the numerous interruptions which take place in consequence of repairs required almost daily.

The introduction of hot air has effect-

ed, in these works, the same economy as in the others cited, where this plan is adopted. One ton of iron required, in 1831, 3 tons of coke, equal to 5 tons 9 cwt. of coal; now, the same quantity of iron consumes 2 tons 14 cwt. of coal, as the following statement shows:

On the 20th July, there passed through the furnace twenty charges, composed of 10 cwt. crude coal, 9 cwt. roasted ore, and 6 cwt. flux. The product being 8 tons of metal, each ton consumed 2 tons 10 cwt. coal for fusion, and 4 cwt. coal for heating the apparatus—total, 2 tons 14 cwt.; ore roasted, 2 tons 5 cwt.; flux, 1 ton 10 cwt.

The consumption in flux was considerable, because of the sulphurous nature of the ore. The slag which came from the furnace was crystalline, and gave off very strong sulphurous odors. Before the introduction of hot air, the daily production of the furnace was only six tons. They have, therefore, obtained, besides an economy in fuel, a diminution of the general expenses, and of labor. The quantity of blast has not been changed, but the tuyeres have been enlarged from two inches nine lines, to three inches six lines.

Part of the iron produced at the works of Mr. Forster is used for the foundry, and part for fine metal; the same running gives both kinds of iron; that which flows first from the hearth, is No. 1 pig metal; the last running gives No. 2. They distinguish the two kinds of iron by the manner in which they run from the furnace, and by the furrows produced on the surface when it cools.

WALES.

There are in Wales but two works using the heated air—that of *Warteg*, and *Blaen-Avon*, ten miles from *Abergaveny*. None of the *Merthyr-tidvyl* works have introduced it, though the *Dowlais* and *Penn-y-danau* have made experiments thereon.

The abandonment of heated air in so extensive an iron country, and in which improvements are sought after with care, has led many to doubt the reality of the advantages claimed for it. Some have thought that, while so much saving was effected by the use of this plan in the furnaces of Scotland, where the metal was destined for the foundry, it could not be employed by other works, the product of which is converted into bar, or malleable, iron.

The examples furnished by the *New-castle*, *Codnor Park*, and *Wednesbury* works, in which they make bar iron of very good quality, prove that this opinion is not well founded. The partial abandonment of the plan in Wales should, in part, be attributed to the bad construction of their heating apparatus, but more especially to the diminished saving which would result to them, since the employment of crude coal has been effected; a saving which the cost of the patent would almost balance. To appreciate these reasons, it is necessary to enter into some details upon the expense of making iron in that country.

From all the information gained upon the experiments made at Dowlais, or Penn-y-danau, it appears that, the apparatus being of bad construction, the temperature of the air could not be raised to more than 300° Fahr. Notwithstanding this, they attempted, with success, the substitution of crude coal for coke. An accident happening to the apparatus, obliged them to suspend the use of hot air for several days, and showed them that, without difficulty, the crude coal could be worked even with cold air. The saving which resulted from this substitution was such, that the proprietors did not deem it worth while to repair the heating apparatus, and thenceforth abandoned it. Since that period, most of the Welsh furnaces use the crude coal, but some employ a mixture of coal and coke.

The following table shows the quantity of fuel and material required to produce one ton of metal.

	Penn-y-danau.			Dowlais.			Cyfartha.			Plymouth.		
	t.	*c.*	*q.*	*t.*	*c.*	*q.*	*t.*	*c.*	*q.*	*t.*	*c.*	*q.*
Coal, . . .	2	9	0	2	14	0	2	13	2	2	13	0
Ore roasted,	2	4	0	2	9	0	2	6	2	1	16	0
Ashes, . . .		2	2		—			—			—	
Flux, . . .		19	2		13	0		16	0		—	

Add to this, the quantity consumed by the blast engines, about the same for each, varying from 5 to 6 cwt.

The average quantity of coal consumed in each of these works is, therefore, two and a half tons for each ton of iron. By the employment of heated air, it is not probable that a saving would be effected over this expense of more than $33\frac{1}{2}$ per cent., or 17 cwt. of coal for each ton of

iron; deduct from this, the fuel consumed to heat the apparatus, estimated at 6 cwt., and the actual saving would be reduced to 11 cwt., costing, at 3*s.* 7*d.*, or 86 cents per ton, at the works, 44 cents; and as the patent right is charged at one half, or 24 cents per ton of iron, the saving would be diminished to 20 cents per ton. This economy, itself very small, would scarcely be appreciated in a district where all the materials are so cheap, that iron may be produced at a less price than in any other district in Great Britain.

I believe, therefore, that the non-adoption of this plan in Wales, is no evidence that it does not effect any saving in fuel; but, on the contrary, it leads me to think that there would be economy, as in other works where the plan is used; but it is evident that, the expense* of coal being very small in Wales, the economy would not be as marked as in the works of Scotland.

The *Warteg Iron Works*, which have been named at the beginning of this section, sustain this opinion. In this establishment, the heating apparatus is composed of a very short developement of pipes, so that the air cannot acquire a temperature of more than 400° Fahr. The coal, which is very bituminous, and loses 55° per 100 in the coking, cannot be employed crude in the furnace, with the air at so low a temperature; it results from these circumstances, that the saving obtained is not so great as at the furnaces of Scotland, but is to be compared to the saving in those works where the apparatus is not so perfect, and where coke is still used. Nevertheless, the diminution in the cost is very marked: before the introduction of heated air, one ton of iron required a consumption of two tons of coke; the produce of four tons, three cwt. of coal. The consumption of coke is still about the same, but, as there is no necessity for carbonizing it so completely, it is now produced by only three tons of coal.

The yield of the furnace has been augmented from six to eight tons of iron, each, in twenty-four hours.

* The author should have attributed this difference, in a great degree, to the superior quality of the Taff Vale coal over the Scotch, the former yielding more than 75 per cent. of carbon, while the proportion in the latter is less than 65 per cent.; some varieties even as little as 51 per cent.—[Trans.]

[From the Richmond Compiler.]

New Moving Power.—The article below from Mr. James Herron, civil engineer, upon the subject of *a new propelling power* upon railroads, is one which deserves, and will unquestionably receive, the calm and dispassionate consideration, not only of scientific men, but of all who feel an interest in the advancement of science. The friends of Internal Improvement should give it their most patient attention. Its novelty may startle them, but what great suggestion in any age did not at first excite doubt of its feasibility? Witness the fate of Fulton and Oliver Evans. They were deemed insane and visionary in their day, but they are now ranked amongst the wisest men of our country, and the sigh of regret often escapes at the ingratitude and dullness of their countrymen.

Mr. Herron may expect to combat with incredulity, ignorance, and personal rivalry; but still he will find intelligent men disposed to consider with an impartial disposition the merits of his scheme. We pretend to but little science, but we confess we are struck with the feasibility of his plan. We think it deserves examination, and we are glad to find that an engineer, high in the estimation of the public, not only gives Mr. Herron's views a fair and liberal consideration, but seems disposed to concur in the principles upon which they are based. In this era of improvement, every man who can make even the slightest addition to the cause of science, should be encouraged to the fullest exertion of his faculties for the public weal.

Hydrodynamic Railway, or the Application of the Power of Rivers to the Rapid and Cheap Transportation of Produce and Merchandise.

It has long been with me a matter of doubt, whether the water used in the lockage of canals was not in many cases an injudicious application of a valuable power, as in the case of a canal located along the valley of a great river having considerable fall in its bed, like that of the river James, which has 1222 feet fall from Covington to tide water, or about 4.74 feet per mile, rendering at least one lock necessary for every two miles in the average.

On investigating the subject, I find that I will therefore lay before you, in as succinct a manner as possible, this new though simple deduction of science.

The locks of the Chesapeake and Ohio the water power of the river is of itself equal to the transportation of a greater quantity of tonnage than can be passed through the largest canal, and this too with the astonishing rapidity peculiar to railroads.

Canal are 100 feet long, 15 wide, and, say we take one of the most approved lift, 8 feet, the "prism of lift" will then contain 12,000 cubic feet of water, which will weigh 750,000 pounds. Every time the lock is emptied, this quantity is transferred from a superior to an inferior level. If the valves are opened simultaneously, I am informed that the lock can be filled and emptied in little more than two minutes; but say that it takes three. Now, this water is power, and if it were applied to a properly constructed "breast wheel," or where the fall of water is greater, to a "pitchback," we should have four-fifths of it available to set any machinery we think proper in motion. Let it be applied to an endless chain or rope, passing over suitable rollers along the line of a railway, after the manner of the stationary system of steam engines, we shall have a water power railway, entirely free from the objections that can fairly be urged to the stationary steam engines, of the necessity of keeping up the fire and steam, &c.

When the stations are two and a half miles apart, one twentieth of the power, according to Tredgold, will be expended in moving the chains; but I will allow a tenth of the power to effect this object on two mile stations, the chain being worked but for one mile.

We have then the four-fifths of 750,000 pounds, (the one-fifth being lost in the application to the water wheels,) equal 600,000 pounds, which, falling 8 feet in three minutes, is equal to 1818 pounds moved half a mile in the same time; which is at the rate of 10 miles an hour. Deducting from this the one-tenth, as that part lost in moving the chain, leaves 1637 pounds. And as 10 pounds are equal to the transportation of a ton, with the commonest railway wagons, it follows that the above power is equal to the transportation of 163.7 tons over half a mile of the road, while a boat would be passing through the lock of the canal; or it will transport 81.8 tons over a mile of the road in the same time, which is at the rate of twenty miles an hour!

But the maximum rate of transportation on canals is 2½ miles an hour, and as the mass moved is inversely to the velocity, we shall at this rate be able to transport 654 tons.

The water used would be at the rate of 66.6 feet per second. James river, even at Covington, in a dry season, yielded nearly three times this quantity, as appears from the Report* of Mr. Crozet, who measured Jackson's river and Dunlop's creek in August and September, 1826. The mean of the results obtained by this engineer is 177.6 cubic feet per second, or 10,656 feet per minute; and we have this quantity with 7.11 feet fall per mile, the average down to Pattonsburg; before reaching which, however, the volume of water is more than doubled; and as we descend the river, although we have less fall per mile, we have at least six times the quantity of water to compensate for it; and the fall is still about 3½ feet per mile.

The heavier trade being descending, will add to the effect of this power; but disregarding this favorable circumstance, omitting the decimals in the fall per mile, and taking the minimum quantity, we have 10,656 cubic feet of water, equal in weight to 666,000 pounds, which, if permitted, will of course fall the 7 feet in a minute, and is therefore equal to 4,662,000 pounds falling one foot. Deducting one-fifth for loss in application, leaves 3,729,600 pounds. Now the load we can transport will depend on the velocity at which we would travel—say that it shall be 10 miles an hour, which is 880 feet per minute.

Dividing 3,729.600 by 880, the quotient is 4,238 pounds, moving with the velocity of 10 miles an hour!

From 4,238 deduct the one-tenth part, for that lost on mile stations, in moving the chain, or rope; and dividing the remainder by 10 for the friction per ton of the carriages, and we have 381.5 tons transported at the rapid rate of 10 miles an hour!

And as each and every mile furnishes its own moving power, it follows that it is equivalent to keeping this quantity in motion on each mile throughout the line at the same time. And as the distance from Richmond to Covington is 257½ miles, this may amount to the enormous quantity of 98,236 tons; or to the transit and delivery of 3,815 tons hourly!

Having thus demonstrated the amplitude of this moving power, to an extent probably far beyond any demand we shall be able to make on it—which will be better understood by the general reader from the fact, that but 17 hours would be equal to the transportation of a greater quantity of tonnage than passed over the whole Baltimore and Ohio Railroad in a year, ending 30th September, 1833—it now remains to show that it can be employed at a reasonable expense.

The expense of erecting works for hydrodynamic transportation will depend on their scale, or magnitude, and on the greater or less permanent character of the materials used in their construction; also, on the extent to which we would employ the motive power. With regard to the latter, however, it should be observed, that we obtain

* 5 Vol. Board of Public Works, page 108.

it so cheaply, and in such excess, as to obviate, to a great extent, the necessity of expensive grading. This adaptation of fixed power to an undulating surface, of any degree of slope, renders it peculiarly applicable to mountain localities, as by its means we can cross the bends of the river, thus shortening the distance, while a canal, or even an ordinary railroad for locomotives, should be conducted round them.

Another important advantage derived from the employment of this cheap power, is that we can substitute, for the iron rail, a broad granite tramway, similar to that extending from London to the West India Docks; which, although it will cost more per mile in the first instance, yet it will have great permanency to compensate for this. But the most important advantage to be derived from the granite tramway, is, that any man may bring his own farm-wagon, and, leaving his horses behind him, be drawn to market at a rate of 10 or 20 miles an hour, which would be in less time than would be spent in passing the locks of a canal: thus freeing the work entirely from the odious charge of monopoly brought against railroads.

To form an estimate of the cost, it will be necessary to suppose the works adapted to some definite amount of trade. Say that it shall be to the delivery of 100 tons per hour, or to the transportation of 50 tons at a time, at the rate of 10 miles an hour.

For this purpose I will suppose it necessary to erect a dam at every four miles; and that they may be built in the most substantial manner of stone masonry, I will estimate them at $10,000 each; the average width of the river up to the Blue Ridge is 699 feet; above the Ridge, it will only be 275 feet. For water wheels of the best and most durable construction, say $3000.

Thus we have 13,000, which, divided by 4 miles, gives $3250 per mile, as the cost of the moving power.

Estimate of the expense.

Motive power, or proportional cost of dams per mile, - - - -	$3,250
Ropes, a double line per mile, -	1,800
Rope rollers, put up, - - -	850
*A broad granite, or marble tramway, double track, - - -	8,000
Grading and bridging per mile, say	2,000
	$15,900
Add 10 per ct. for superintendence,	1,590
	$17,490

* Wood and iron rail tracks, like those on the Petersburg Railroad, could be laid in a double track for 6000 dollars a mile. They would last much longer than when locomotives are used.

High and unfavorable as the above estimate is, yet the whole cost of the moving power, including dams, water wheels, ropes, and rollers, will be much less per mile than such locks as those of the Chesapeake and Ohio Canal, which cost, as I am credibly informed, $1500 the foot lift.

I have estimated for ropes, as they are in more general use than chains; and the above will be the cost of the newly invented rope, saturated with India rubber, expressly for this purpose; which is said to increase its strength as well as its durability.

When the stations or water wheels are placed 4 miles apart, each wheel would have to work 2 miles of the road at a time; but did the trade require it, double, or probably treble the foregoing tonnage, could be delivered by erecting an additional water wheel at each station.

The following is the estimate of the amount of power to work the 4 mile stations, which those conversant with the subject will perceive to be very ample.

Friction and resistance of two miles of rope, - - - -	600 lbs.
Ordinary friction of 50 tons of carriages and goods, 10 lbs. -	500 do.
Allowance for occasional gravity, at 20 lbs. per ton, - -	1000 do.
Power allowed at the rate of ten miles an hour, - - -	2100 do.

2100 pounds moved 880 feet in a minute, is equal to 1,848,000 pounds moved 1 foot; which is equal to 154,000 pounds falling 12 feet in the same time, which is, also, equal in weight to 2464 cubic feet of water. To which add one-fourth, for loss in application, and we have 3080 feet per minute, or rather more than 51 feet per second.

For the sake of conveying an idea of the probable cost on a large scale, I have supposed isolated dams to be used at regular distances, but the engineer will of course adapt his works to suit particular localities, sometimes preferring a continuous canal, substituting water-wheels in place of locks, and thus discharging the water, as it is used, into the next consecutive reach below. Or where great length of level occurs, the wheels may be made to discharge their water into the river, to be again taken out of the next dam.

On canals already constructed, where they have considerable lockage, and plenty of water, it is obvious that the trackage may be effected by the foregoing means; that is, by erecting a water-wheel along side of a lock, and extending a chain down the margin of the canal on the one side, which would be returned up the other.

And as they no longer need the tow-path,

they may lay a light rail track, on which passenger cars may be drawn by the same power at any required velocity.

But in many cases, where they have not a superfluity of water, they had better substitute water wheels for their lock gates, widen their tow-path, and lay down a railway.

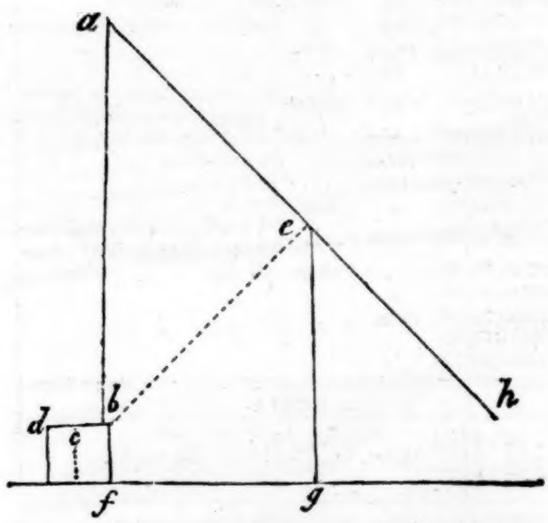
In conclusion, I invite investigation by men of science, as it is certainly a subject of great importance to the country, now so extensively engaged in works of internal improvement.

JAS. HERRON,
Civil Engineer.

Richmond, Va., May 26, 1835.

[For the Mechanics' Magazine.]

To find the Length of the Sweep and Crutch for a Well—the Depth of the Well given.



Rule—The square root of half the square of the depth of the well, with the height of the curb added, is equal to the distance from back side of curb to centre of pin on which the sweep hangs; and the square root of half the space of that distance, with half the width of the curb added, is equal to the distance the crutch should be from the well, and the height of curb added gives the height of the crutch from the ground, consequently the length of the sweep will be twice the distance from the curb to centre of pin, less one foot. But to make it work easy, there should be an allowance of about six inches in height, and in the distance from the well, that is, the pin 6 inches lower, and 6 inches further from the well, which will give about one foot more on upper end of sweep, which allowance is in consequence of the upper end of the sweep being smaller.

Thus—$\sqrt{a\,b^2 \div 2} = b\,e$

$\sqrt{b\,e^2 \div 2} + c\,b = g\,f$

$\sqrt{b\,e^2 \div 2} + f\,b = g\,e$

Then, $2b\,e = a\,h$.

Examples—I have a well 21 feet deep, and the curb around it 3 feet high, and 3 feet square—required to know the length of the sweep, height of crutch above the ground, and how far I must set the crutch from centre of the well.

$21 + 3 = \sqrt{21^2 \div 2} = 17$ feet, distance $b\,e$ from curb to pin.

$\sqrt{17^2 \div 2} + 1.5 = 13.528$ feet, distance from well.

$\sqrt{17^2 \div 2} + 3 = 15.028$ feet, height of the crutch.

And $17 \times 2 - 1 = 33$ feet, length of sweep.

Then, as was stated above, we will make an allowance of six inches, or 0.5 of a foot,

$13.528 + .5 = 14.028$ feet.

$15.028 - .5 = 14.528$ feet.

S. A.

A Friend to Canals and Railroads will find in the Railroad Journal, if he uses it, the most extensive, and probably the most careful, investigation of the subject of canal navigation, that has been published. He will find, however, that according to these experiments, broad canals are not considered by Mr. Macneill as best adapted for speed.

To the Editor of the Mechanics' Magazine:

In the valuable letter of Gerald Ralston, in your last number, he speaks of General Mercer truly as the "advocate of broad and deep canals for transportation." He also advocates, and has long endeavored to draw the attention of those interested in canals, to the use of the Paisley passage boats. The principle on which their success has depended has not yet been demonstrated. But those on which he has advocated the superiority of wide and deep canals for transportation have been long known, and their truth admitted. An exemplification is given in the difference of strain on the horses on the Schuylkill canal; on the narrow canals it is hard, on the pools, easy.

You could not better serve the cause of internal communication, than by accepting the offer of Mr. Ralston, and request him to give all the information which his time and opportunities will permit on the subject of these swift canal boats.

A FRIEND OF CANALS AND RAILROADS.

METEOROLOGICAL RECORD, for the months of January, February, March, and April, 1835—kept at Avoylle Ferry, Red River, Lou. (Lat. 31° 10′ N., Long. 91° 59″ W.) by P. G. VOORHIES.

JANUARY.

Days.	Morn.	Noon.	Night.	Wind.	Weather.	Remarks.
1	42	64	62	calm	clear	all day
2	54	72	68	SW	cloudy	..
3	50	48	46	calm	..	..
4	32	48	42	N	clear	..
5	29	54	45	calm	..	heavy white frost
6	29	46	44	..	..	.. ..
7	34	50	50	..	cloudy	rain all day and night
8	36	48	45	NE	..	all day
9	38	46	43	calm	..	..
10	37	55	56	SE	..	..
11	46	53	58	calm	..	rain all day
12	61	64	64	SE	..	rain & h'vy thunder in e.
13	48	62	68	W	clear	all day—Red river rising—wind high
14	52	64	69	SW	cloudy	rain all day
15	46	58	52	W	clear	all day
16	32	54	56	calm	..	..
17	44	66	62	SW	..	..
18	40	68	56	calm	..	..
19	33	63	54	E	..	heavy white frost
20	60	66	64	SE	cloudy	rain all day
21	54	65	58	N	..	evening clear
22	38	67	60	S	clear	white frost
23	49	65	62	calm	cloudy	rain
24	58	70	65	S	..	rain, and heavy thunder
25	62	72	67	calm	clear	all day
26	70	86	70	..	..	..
27	60	71	64	..	..	..
28	46	71	68	W	..	..
29	70	68	56	SW.high	cloudy	from 2 to 9 a. m., most vivid lightning & h'vy thunder, light showers
30	34	41	40	W.high	clear	morn'g—day cloudy—wind high all day, WNW
31	30	42	46	calm	..	all day.

FEBRUARY.

Days.	Morn.	Noon.	Night.	Wind.	Weather.	Remarks.
1	40	56	52	calm	clear	all day—Red river rising
2	49	66	65	..	..	foggy morning—clear day—rain all night
3	40	40	40	NW.high	.	all day—most extraordinary, all day equal!
4	24	40	39	calm	..	all day—rain at night
5	28	45	46	..	..	a white frost—cloudy evening—rain at night
6	47	46	44	..	cloudy	and rain—clear evening—wind N, high
7	24	29	26	N to NW	clear	all day—wind high
8	12	26	27	calm	..	all day—coldest ever known in this country
9	20	40	46	..	..	all day
10	29	44	42	..	..	.. —white frost
11	28	54	48	..	..	.. ..
12	32	58	50	..	..	.. ..
13	38	66	64	SW.high	..	.. .. light
14	49	68	68	S to W	cloudy	rain at night
15	34	40	42	W to NW	..	some spits of snow
16	31	44	42	calm	clear	white frost
17	29	54	52	..	..	..
18	34	64	60	..	..	..
19	45	70	64	..	..	
20	49	65	66	SW	cloudy	
21	58	74	70	S.high	..	rain & h'vy thunder all n.
22	60	60	56	calm	..	.. .. all day
23	50	55	52	..	..	evening clear
24	46	59	58	..	..	morning—clear day
25	58	69	66	..	..	all day
26	50	37	36	N.high	..	rain, hail, and sleet
27	23	32	33	calm	clear	ground covered with ice
28	25	45	41	..	..	ice remains in the shade.

MARCH.

Days.	Morn.	Noon.	Night.	Wind.	Weather.	Remarks.
1	30	50	48	calm	cloudy	white frost
2	40	50	52	..	..	light drift'g showers all d.
3	51	67	63	S	..	light drifting showers—rained at night
4	42	38	39	NE.high	..	light drifting showers, and rain at night
5	34	39	42	N	..	rain, snow, and sleet
6	34	48	43	calm	clear	white frost
7	40	44	44	..	cloudy	rain all day
8	43	52	50	..	..	all day
9	46	54	52	..	..	evn'g wind N to NW, clear
10	41	58	50	..	clear	white frost
11	36	61	61	..	..	great flight of wild geese this morn'g to N
12	40	66	60	slight	.	all day
13	51	70	68	S	cloudy	..
14	62	76	73	S.high	..	..
15	68	73	71	calm	..	..
16	60	77	70	..	clear	night cloudy—sowed oats and red clover—began planting corn
17	58	58	54	NE	cloudy	rain at night
18	50	67	66	SE	..	rain in morn'g, ev'g clear
19	47	65	64	calm	clear	
20	50	71	67	SE	..	
21	68	78	65	S.high	cloudy	rain at night—a heavy gale from west all night
22	45	61	60	W.high	clear	wind high fm W. all day
23	38	59	58	calm	..	white frost
24	42	65	60	S.light	..	
25	58	69	64	S	cloudy	
26	62	70	66	calm	..	heavy thunder and rain in morning—day clear
27	45	74	70	..	clear	all day
28	48	80	66	S	..	..
29	50	76	72	calm	..	..
30	54	78	76	..	..	..
31	66	86	75	..	..	..

APRIL.

Days.	Morn.	Noon.	Night.	Wind.	Weather.	Remarks.
1	60	71	69	calm	cloudy	Red river rising
2	60	76	71	S.light	..	
3	61	75	68	calm	clear	
4	54	74	68	NE	..	smoky, pine woods on fire
5	44	67	61	calm	..	..
6	43	66	56	NE	..	foggy morning—day clear
7	44	68	61	NW.light	..	.. ..
8	45	72	72	calm	..	smoky
9	50	65	60	..	cloudy	.. —rain at night
10	50	72	66	..	clear	foggy morning—clear day
11	60	77	68	S.high	..	all day [river at a stand
12	66	73	70	S.light	cloudy	shower in the morning
13	56	68	63	NE	..	all day—river falling
14	57	61	56	N	..	..
15	52	58	50	NE	..	rain and showers all day
16	46	66	60	calm	clear	
17	44	70	64	SE	..	
18	60	61	63	..	cloudy	rain all day
19	71	71	69	S.high	..	drizzling all day
20	66	71	65	calm	..	.. ..
21	56	72	64	..	..	
22	58	72	72	..	..	
23	54	80	74	..	..	foggy morning
24	62	72	70	..	..	clear at noon
25	70	72	67	SE	..	thunder and rain all day
26	64	72	70	calm	..	
27	64	70	66	N	clear	Red river rising
28	50	72	68	calm	..	
29	58	68	70	SW	cloudy	rain and thunder all day
30	70	76	72	calm	clear	.. .. in even'g.